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Report to
Montana Water Pollution
Council – Nov. 1960

Water Pollution in the Missouri River Drainage in Montana

Sewage Lagoon

Mechanical Treatment Plant Under Construction

Progress Report No. 60-1
Montana State Board of Health
Helena, Montana

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Report to Montana Water Pollution Council, November, 1960
WATER POLLUTION IN THE MISSOURI RIVER DRAINAGE OF MONTANA

Progress Report 60-1
Montana State Board of Health

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FOREWORD

With the passage of a revised Water Pollution Act by the 34th Legislative Assembly in Montana in 1955, it was recognized that recreational, industrial and agricultural uses of Montana's waters, in addition to previously recognized health uses, should be protected. This made necessary the gathering of more complete data than was available through previous State Board of Health studies concerning existing pollution and the cataloging of environmental characteristics of the natural waters of the state. This information is necessary for the classification of natural waters on the basis of their most beneficial uses by the Water Pollution Council.

This report summarizes pollution data from the State Board of Health files and stream data obtained during the summers of 1958 and 1959. Also included in the report is a proposed stream classification for the Missouri River and tributaries except the Yellowstone and Little Missouri River Drainage Areas. These were previously classified by the Water Pollution Council on September 2, 1958 following a public hearing in Billings on June 10, 1958.

The Missouri River Drainage Basin covered in the proposed classification includes 57% of Montana's 146,131 square miles and consists for the major part of clean streams. It is the intent of the proposed stream classification to provide the most beneficial uses of waters in Montana for the people of Montana.

This report was prepared for Council consideration as well as for reference at the public hearing on the classification of the Missouri River scheduled in Great Falls, Montana, December 6, 1960.

The Fish and Game Department biologists assisted materially in the summer team studies of 1958 and 1959 and in compiling this report.

G. D. Carlyle Thompson, M.D.
Executive Officer
Montana State Board of Health

November 29, 1960

TABLE OF CONTENTS

	Page
Introduction	1
Acknowledgments	1
Summary	2
Recommendations	4
General Description of Area	5
Uses of Water Resources	7
Disposal of Wastes	9
Survey Information Provided	19
Chemical and Physical Procedures and Results	20
Bacteriological Procedures and Results	31
Biological Procedures and Results	35

TABLES

Table 1 - Municipal Water Supplies from Surface Sources	8
Table 2 - Status of Municipal Sewage Disposal	12
Table 3 - Status of Industrial Wastes Treatment	18
Table 4 - Hydrological Data	24
Table 5 - Twenty-four Hour Sampling, Station No. 33	27
Table 6 - " " " " " " 36	27
Table 7 - " " " " " " 36	28
Table 8 - " " " " " " 61	28
Table 9 - " " " " " " 73	29
Table 10 - " " " " " " 90	29
Table 11 - " " " " " " 99	30
Table 12 - " " " " " " 100	30

FIGURES

Figure I - Status of Municipal Sewage Treatment	11

MAPS

Map 1 - Location Map	41
Map 2 - Location of Sampling Stations	42
Map 3 - Location of Sampling Stations	43
Stream Classification Map	59

APPENDICES

Appendix A - Locations and Descriptions of Sampling Stations	44
Appendix B - Chemical, Physical and Bacteriological Data	55
Appendix C - Biological Data	57
Appendix D - Proposed Stream Classification	60
Appendix E - Stream Criteria for Wastes Discharges	67

INTRODUCTION

This is the third of a series of reports published by the Montana State Board of Health on stream pollution studies. The first, "Pollution of the Yellowstone River" was written in 1956 in conjunction with the U. S. Public Health Service. The second, "An Extensive Chemical, Physical, Bacteriological, and Biological Survey" was released during 1959 and covered the Columbia River Drainage in Montana. Information and data for the following report were obtained from files of the State Board of Health and from stream surveys made during the summers of 1958 and 1959.

The primary purpose of this report is to present the available information in more or less summary form to the Montana Water Pollution Council to aid the Council in their classification of the streams of the state. The Montana State Board of Health is instructed by the Water Pollution Act of 1955, enacted by the 34th Legislative Assembly of Montana, "to conduct as it deems necessary, studies, investigations, research and demonstrations relating to water pollution and the causes, prevention, control and abatement thereof." The Water Pollution Act provided for the establishment of a seven member Water Pollution Council and one of its duties authorized by the Act is "to group such waters into classes in accordance with their present and most beneficial uses in the interest of the public and such classifications or standards may from time to time be altered and modified."

The streams of the Missouri River drainage area in Montana are among the last streams in the state to be classfied; previous classifications having been made of the Yellowstone, Clark Fork, and Kootenai River Drainage systems. The suggested classification of the streams for this drainage area are given in Appendix D. The Water Pollution Council's Stream Criteria for Waste Discharges is shown in Appendix E.

Another purpose of this report is to tabulate the data obtained by the survey team during 1958 and 1959 so that the data is available for future reference by state organizations and any other interested parties. The biological data, in particular will be of value in comparing the condition of the stream during 1958 and 1959 and, for example, ten years from now after further industry and population has moved into the area. As these are, in the major part, clean streams these data will be invaluable in the administration of Montana's pollution control program.

As a thorough discussion regarding survey procedures and the significance of each determination was given in the Montana State Board of Health report "An Extensive Chemical, Physical, Bacteriological, and Biological Survey", these items will be only touched lightly in this report.

ACKNOWLEDGEMENTS

The survey data for this report was obtained by the State Board of Health summer crew consisting of Dr. Sheldon P. Hayes, Microbiologist of the Weber College, Ogden, Utah teaching staff; Mr. N. Bruce Haynes, Sanitary Engineer of the Montana State College engineering teaching staff, and Mr. Martin Houle and Mr. Hugh R. McLean, chemists.

Assistance was provided by the Montana Fish and Game Department by the assigning of a biologist to the State Board of Health staff for technical assistance at the time of the stream survey, for compiling, tabulating, and analyzing stream survey data, for the writing of the biological section of this report, and for other stream pollution control activities.

The cooperation of the many land owners, industrial, municipal, county and state officials contacted by the survey crew is greatly appreciated.

Thanks is tendered to the U. S. Geological Survey, Helena, Montana for their assistance in providing flow data and gaging equipment.

A considerable amount of general information for this report was obtained from a U. S. Public Health Service report "Upper Missouri River Drainage Basin" dated May, 1952.

SUMMARY

1. In order to obtain basic information necessary for the classification of streams and the establishment of standards of water quality by the Montana Water Pollution Council, the State Board of Health conducted a physical, chemical, bacteriological, and biological survey of the Missouri River drainage in Montana during the summers of 1958 and 1959. A proposed classification for the Missouri River Basin streams has been submitted to the Water Pollution Council.

2. Sampling stations were established above and below known sources of pollution, above and below entering streams, and in streams free of major pollution.

3. The Missouri River basin in Montana represents an area where prevention and not clean-up of stream pollution is the main job of the pollution control agency.

4. Low dissolved oxygen concentrations (below 5 ppm) were found at two stations; below the Town of Whitehall sewage discharge on Whitetail Creek and below the City of Bozeman sewage discharge on the East Gallatin River.

5. Twenty-two communities obtain their water supplies from surface sources in the Missouri River Basin. The municipalities of Brady, Bozeman (Bozeman and Hyalite Creeks), Butte (Big Hole River), Conrad, Culbertson, East Helena and Helena (Ten Mile Creek) need additional treatment of their surface water supplies. Present treatment is adequate for a Class "A" water supply where additional treatment is needed for a Class "B" water supply.

6. Class "B" water treatment is provided for the communities of Fort Benton, Chinook, Harlem, and Fort Belknap even though sewage treatment or additional sewage treatment is needed by upstream communities to assure a safe supply for Class "B" treatment. The cities of Great Falls and Havre are the principle offenders. The City of Great Falls is presently constructing an adequate treatment plant while the City of Havre must properly chlorinate its sewage effluent.

7. The Beaverhead River in the Dillon and Twin Bridges areas exceeds the MPN limits for a Class "C" stream. Further study is needed in each of these areas to determine the cause, although it would appear that individual sewage discharges are responsible. Biological tests also indicated polluted conditions at these stations.

8. The Jefferson River in the Whitehall and Three Forks areas and Whitetail Creek below the Whitehall sewage discharge exceed the MPN limits for Class "C" streams. The communities of Whitehall and Three Forks have adequate treatment facilities scheduled for completion during 1961 to lower the MPN count on these streams. Biological samples on Whitetail Creek also indicated polluted conditions.

9. In the Bozeman area, Bozeman Creek, Bridger Creek and the East Gallatin River greatly exceed the MPN limits for Class "C" streams. Treatment of wastes from the Vollmer Slaughterhouse and chlorination of the Bozeman sewage effluent are needed. Local action is also needed in the Bozeman area to eliminate individual sewage discharges to nearby streams. Biological samples also indicated polluted conditions in the East Gallatin River.

10. Chlorination of the Bozeman sewage effluent and construction of new sewage treatment facilities by the Town of Manhattan in 1961 should lower the MPN values in the Gallatin River to make it an acceptable Class "C" stream.

11. Further treatment of sewage is needed by the community of Trident on the Missouri River.

12. Extremely high MPN counts were found below the City of Helena sewage discharges on Ten Mile and Prickly Pear Creeks. The new Helena sewage treatment plant is scheduled to be placed into operation by December, 1960 to eliminate this condition.

13. Chlorination of the City of Lewistown sewage treatment plant effluent and plant expansion is needed. MPN counts on Big Spring Creek and the Judith River below the City of Lewistown exceed the limits for a Class "C" supply. Biological samples also indicate the pollution of Big Spring Creek by Lewistown sewage.

14. Biological samples from Willow Creek near the Town of Browning indicated polluted water conditions. New treatment facilities are needed by Browning.

15. Biological samples from the Musselshell River below the City of Harlowton indicated polluted water conditions. Harlowton has constructed adequate sewage treatment facilities since the survey.

16. The Milk River below the City of Havre greatly exceeds the limits for a Class "C" water supply. Additional chlorination of the Havre sewage effluent is needed along with possible secondary treatment of the effluent. The communities of Dodson Malta, and Glasgow have constructed adequate treatment facilities since the survey and adequate treatment facilities need to be constructed by the communities of Hinsdale, Nashua, and Fort Belknap.

17. Treatment is needed of the sewage from the communities of Fort Peck and Poplar on the lower Missouri. Construction of adequate treatment facilities by Fort Peck will probably be started during the later part of 1960. The City of Wolf Point has constructed treatment facilities since the survey.

18. Although the effects of wastes from the Great Falls Meat Packing Company and the communities of Bainville, Cascade, Fort Harrison, Lavina, Medicine Lake, Saco, Scobey, Stanford, Vaughn and Winnett were not determined during the survey, treatment or further treatment is needed to meet minimum treatment requirements established by the Water Pollution Council.

19. Eighty-seven percent of the population in the Missouri River Basin in Montana is served by adequate sewage treatment facilities or will be served by adequate facilities by 1961.

20. Fourteen percent of the biological samples taken during the survey indicated polluted water conditions. Since a major part of the samples were collected below known sources of pollution and many of these sources of pollution have since been eliminated, the Missouri River Basin streams could be considered in the major part clean water streams. However, a resurvey of part of the streams is indicated within the next few years after additional sources of pollution have been eliminated.

RECOMMENDATIONS

1. The proposed stream classification for the Missouri River Basin streams be adopted by the Montana Water Pollution Council.

2. Facilities for treatment of slaughterhouse wastes by the Great Falls Meat Packing Company, Great Falls, and Vollmer Slaughterhouse, Bozeman be constructed.

3. Adequate settling ponds for mill wastes be constructed at the Northern Mills near Townsend.

4. A local pollution control program is needed in the Bozeman area and possibly in the Dillon area to prevent individual sewage discharges to streams. A community sewer system is needed by the Town of Twin Bridges to eliminate present individual discharges.

5. Chlorination of sewage effluents at Bozeman, Lewistown, Lavina, Malmstrom Air Force Base and Vaughn be initiated. The chlorine dosage at Havre be maintained at a proper level.

6. Additional sewage treatment facilities or new facilities be provided at Bainville, Browning, Cascade, Fort Harrison, Fort Belknap, Hinsdale, Lewistown, Nashua, Medicine Lake, Poplar, Saco, Scobey, Stanford, Trident and Winnett.

7. Further investigation be made to determine whether Havre and Bozeman need secondary sewage treatment.

8. Additional water treatment facilities be constructed at Bozeman, Butte, Brady, Conrad, Culbertson, East Helena and Helena to treat a Class "B" water supply.

9. A resurvey be made of at least part of the Missouri River Basin streams in a few years to note changes in stream conditions.

GENERAL DESCRIPTION OF AREA

Physical Description

The Missouri River as it leaves Montana and enters North Dakota has provided drainage for approximately 94,000 square miles. A very small portion of this drainage area lies within Yellowstone Park, Wyoming and North Dakota. Approximately 83,000 square miles are in Montana and 9,000 square miles are in Canada.

The Missouri River is considered to be formed near Three Forks, Montana, by the junction of the Jefferson, Madison, and Gallation Rivers, although some geographers consider the main stem of the Missouri to extend above Three Forks through the Jefferson and its tributaries, namely the Beaverhead and Red Rock Rivers, to the source of the Red Rock River as the ultimate beginning of the Mississippi-Missouri River system. From Three Forks the river flows in a generally northern and northeasterly direction for a distance of about 400 miles, thence easterly to the North Dakota boundary. Within the state of Montana, approximately 800 miles of the Missouri River traverse the drainage area as measured from its origin near Three Forks to the North Dakota boundary.

The river lies in the northern Rocky Mountain region from its headwaters to the vicinity of Great Falls, Montana. The Missouri enters the Great Plains region 30 miles upstream from Great Falls at a point called "The Gates to the Mountains," as named by Lewis and Clark. It is a clear, swift flowing stream with a discharge of considerable magnitude.

The Jefferson River has a total drainage area of 9,520 square miles and a length of 248 miles. The Jefferson is formed by the junction of the Beaverhead and Big Hole Rivers just north of Twin Bridges, Montana, from whence it flows northeast to its junction with the Madison and Gallatin Rivers near Three Forks, Montana. Its principal tributary is the Boulder River which rises in the vicinity of Deer Lodge National Forest along the eastern slope of the Continental Divide. Other tributaries of importance are the Big Hole River, Pipestone, Whitetail, South Boulder, and Willow Creeks. The average slope of the Jefferson River is 19.3 feet per mile.

The Madison River, which is formed by the junction of the Firehole and Gibbon Rivers in Yellowstone National Park in Wyoming, flows west to the vicinity of Cliff Lake where it turns north to its junction with the Jefferson and Gallatin Rivers. It drains a total of 2,520 square miles. The Firehole River rises near the Upper Geyser Basin in Yellowstone Park and is fed by the geysers and hot springs of Upper and Lower Geyser Basins.

The Gibbon River rises near Grebe Lake in Yellowstone Park from whence it flows southwest to join the Firehole River. Throughout much of its length the Madison has formed steep-sided canyons and medium size valleys. The flood plains are flanked by series of coarse gravel terraces rising to about 150 feet above the river. The river is 183 miles in length and has a slope of approximately 25.1 feet per mile.

The Gallatin River is formed by the junction of the West Gallatin and East Gallatin Rivers. The West Gallatin River rises in the northwest corner of Yellowstone National Park and joins the East Gallatin at Logan, Montana. Other principal tributaries of the Gallatin system are Taylor Fork, West Fork, Spanish Creek, and Hyalite Creek. The Gallatin drains a total area of 1,840 square miles and through the West Gallatin, its principal tributary, is approximately 120 miles in length. Its average slope is 41.7 feet per mile.

The major tributaries of the Missouri River below Three Forks, Montana, include the Dearborn, Smith, Sun, Marias, Judith, Musselshell, Milk and Poplar Rivers. The Marias, Musselshell and Milk Rivers are the largest of the group, each having more than 9,000 square miles of drainage area.

The Milk River rises in the extreme northwesterly portion of the Upper Missouri Basin and flows northward into Canada and includes in its drainage area the extreme southern portions of the province of Alberta, and the southwestern corner of the province of Saskatchewan. It then returns across the International Boundary into Montana and flows in a southeastwardly direction to join the Missouri River at a point about 11 miles downstream from Fort Peck Dam. It drains an area of 24,326 square miles, of which 8,279 square miles are located in Canada. The stream is 729 miles in length and has an average slope of 6.8 feet per mile. The principal tributaries of the Milk River include Big Sandy, Lodge, Battle, White Water, Frenchmans, Beaver, and Rock Creeks. For most of its length the river lies in the high plains region. Its flow is normally small but varies between great extremes.

Many of the streams of the Basin are fed from natural hot springs. Such springs are found at Bozeman Hot Springs in Gallatin County; Potosi, Ziegler, and Barkell Hot Springs in Madison County; Elkhorn and Jackson Hot Springs in Beaverhead County; Pipestone, Alhambra, and Boulder Hot Springs in Jefferson County; White Sulphur Springs in Meagher County; Broadwater Springs in Lewis and Clark County, and in the Geyser Basin of Yellowstone National Park. Natural cold water springs at Great Falls, Lewistown, and Toston, Montana, have flows of 300,110, and 60 cubic feet per second respectively.

Mineral resources are found in almost every section of the Missouri drainage area. These include gold, silver, copper, lead, zinc, phosphate, and coal. Oil and natural gas fields have been located in the lower portion of the drainage area.

Climate

Due to great differences in elevation throughout the Upper Missouri Basin (2,000,to 11,000 feet) climatic conditions vary widely. Precipitation

varies from 10 to 20 inches, with the greatest amount falling in the mountains. The great plains area seldom receives more than 14 inches of moisture per year. Seventy to 75 percent of the precipitation in the plains region occurs between April 1 and September 1. Snowfall ranges from 30 inches in the Milk River Basin to as much as 10 to 15 feet in the mountainous area.

The average growing season varies from 29 days at Gold Butte, Montana, to a maximum of 185 days in the lower plains. Average of the lower plains region, however, is from 115 to 125 days. Frosts occur every month of the year in some portions of the Basin. The temperature range is likewise great. The winters are normally very cold with short, hot summers. In the Milk River Basin the mean monthly January temperature is 11.1° while the July mean monthly temperature is 69.7° F. The winters throughout the area are frequently moderated with warm, dry winds known as "Chinooks" which rapidly melt the snow, dry the ground, and introduce short periods of pleasant weather.

USES OF WATER RESOURCES

The earliest uses of water in the Basin were for transportation and hydraulic mining. The use of water for placer mining, or jetting of gold from the creek banks, was the basis for the present Law of Water Rights in Montana. The first water right established in the Upper Missouri Basin was acquired on Elkhorn Creek in Jefferson County in 1861.

The Missouri River and its tributaries are used as sources of public water supply for 22 cities and towns. Table 1 gives the location of these supplies and the treatment provided. The Appendix D map also indicates the location of these supplies.

Irrigation is an extremely important use of water in this area. There are about a million acres under irrigation. An additional one and one-half million acres are considered irrigable. Large irrigation projects now exist in the Milk River Valley, along the Sun and Marias Rivers, and in the valleys of the Madison, Gallatin, and Jefferson Rivers.

There is considerable hydroelectric power development in the region. The principal power plants are located at Black Eagle, Ryan, Rainbow, Cochrane and Marony Dams in the vicinity of Great Falls. Other regulatory works and power plants are located at Hebgen Reservoir on the Madison River and Hauser, Holter and Canyon Ferry Dams on the Missouri River. Downstream at Fort Peck Dam a large generating plant has been installed by the Corps of Engineers.

The Anaconda Copper Mining Company has a large smelter at Black Eagle, Montana, across the river from Great Falls, which electrolitically purifies copper and zinc. The smelter was located here in order to utilize the electricity produced at the nearby hydroelectric power plants, and to have available a sufficient volume of water for cooling purposes. The oil refinery at Great Falls is also dependent upon the river for its water supply.

TABLE I

MUNICIPAL WATER SUPPLIES FROM SURFACE WATERS
IN MISSOURI RIVER BASIN OF MONTANA

Municipality	Source	Treatment
Basin	Basin Creek	Chlorination
Bozeman	Bozeman, Lyman and Hyalite Creeks	Chlorination
Brady	Impoundment from irrigation ditch	Chlorination
Butte	Big Hole River	Chlorination
Chinook	Milk River	Coagulation, filtration and chlorination
Conrad	Lake Francis & irrigation ditch	Chlorination (coagulation, filtration and chlorination of irrigation ditch supply during its usage)
Culbertson	Missouri River	Chlorination
Cut Bank	Cut Bank Creek	Coagulation, filtration and chlorination
Dillon	Rattlesnake Creek	Chlorination
East Helena	McClellan Creek	Chlorination
Fort Belknap	Milk River	Coagulation, filtration and chlorination
Fort Benton	Missouri River	Coagulation, filtration and and chlorination
Fort Peck	Missouri River	Coagulation, filtration and chlorination
Glacier Park Station	Midvale Creek	Chlorination
Glasgow Air Force Base	Missouri River	Coagulation, filtration and chlorination
Harlem	Milk River	Coagulation, filtration and chlorination
Havre	Milk River	Coagulation, filtration and chlorination

Table I Continued

Municipality	Source	Treatment
Helena	Ten Mile Creek and Missouri River	Coagulation, filtration and chlorination of Missouri River water when used. Chlorination of Ten Mile Creek Supply.
Neihart	O'Brien Creek	None
Sheridan	Indian Creek	Chlorination
White Sulphur Springs	Willow Creek	Chlorination

Page 7 Continued

Trout fishing in the Upper Missouri Basin constitutes some of the finest in the nation. Thousands of anglers are attracted yearly by the splendid fishing afforded them in the Big Hole, Gallatin, Beaverhead, Wise, Madison, Sun and Dearborn Rivers. The streams mentioned are particularly well known, however, there are innumerable tributaries that also offer excellent fishing. Rainbow, cutthroat, eastern brook and brown trout, and mountain white fish are found in abundance.

There is little commercial navigation in the streams, however, a considerable fleet of small power craft operate on Hebgen, Holter, Hauser, Canyon Ferry, Fort Peck, Tiber, and Fresno Lakes.

DISPOSAL OF WASTES

Sixty-nine municipalities and communities having a 1950 population of 148,999 have sewer systems in this drainage area. Forty-four of these serving 65,140 have sewage treatment facilities considered adequate while another seven serving 64,042 have construction underway or construction to begin during 1960. Included in the seven municipalities are Great Falls and Helena which are presently discharging untreated sewage to the Missouri River and its tributaries. Eighteen of the remaining municipalities serving 19,817 have no treatment facilities, or present treatment is considered inadequate to meet Water Pollution Council Criteria (Appendix E) which places the minimum treatment of domestic sewage at primary treatment and effective disinfection or sewage lagoon treatment. Figure I summarizes the status of sewage treatment while Table 2 gives the status of individual communities on October 1, 1960.

Industrial pollution in the area is low as the area overall is very lightly industralized. The Great Falls area is the most extensively industrialized with the Anaconda Company Reduction plant, the Phillips refinery, two meat packing plants, a brewery, the Great Northern Railway Shops, flour

mills and other smaller industries-contributing small loads to the Missouri River. An example of recent pollution was the discharge of phenolic wastes by the Phillips Refinery to the Missouri River in March, 1959 and the resultant chlorophenolic taste in the Fort Benton water supply. This discharge was made knowingly by the refinery, but at a rate that was thought would not cause any detrimental affects to the river. The refinery has made assurances that a similar discharge will not happen again.

Table 3 lists the status of wastes treatment of the industries with the greatest potentiality for stream pollution, however, most of the wastes are being taken care of satisfactorily. There are many smaller industries throughout the state contributing small pollution loads to the Missouri and its tributaries such as small meat packing plants, creameries, gravel washing operations, small mining and milling operations, etc. In most instances these create only localized nusiance conditions and knowledge of these are usually learned by individual complaints.

One of the duties of the State Board of Health as set forth in the Water Pollution Act is "to issue, continue in effect, revoke, modify or deny permits to any person for the collection and discharge of sewage and industrial and other wastes under such conditions as the Council may prescribe to achieve the purposes of this Act."

There are areas in the state where improper irrigational practices contribute to the degradation of the stream. The lower portion of the Sun River and the Milk River are examples of this.

The Missouri River Basin in Montana represents an area where prevention and not clean-up of stream pollution is the main job of the pollution control agency.

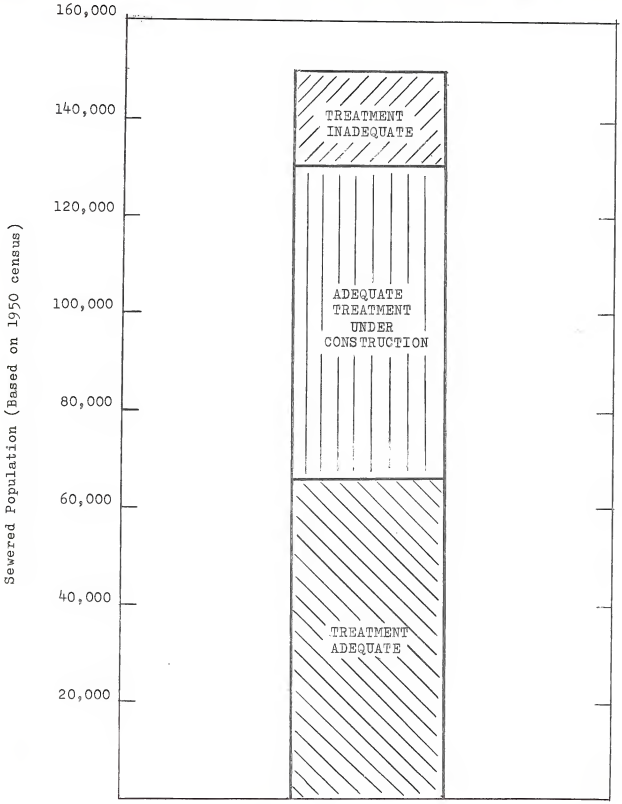


FIGURE I
STATUS OF MUNICIPAL SEWAGE TREATMENT
IN
MISSOURI RIVER BASIN OF MONTANA
OCTOBER 1, 1960

TABLE 2

Status of Municipal Sewage Treatment
in Missouri River Basin of Montana
October 1, 1960

Municipality	1950 Census Population	Discharge to	Mileage	Treatment Provided	Additional Treatment Needed	Community Action
Bainville	356	Shotgun Creek	1700-8	Imhoff tank	Secondary	None
Belgrade	663	---	---	Septic tank	None	Effluent seeps into gravel beds
Big Sandy	743	Big Sandy Creek	1857.4-412-36	Lagoon	None	
Boulder State School	700*	Boulder River	2464-33-42	Lagoon	None	
Bozeman	11,252	East Gallatin River	2464-10-31	Primary treatment	Chlorination and possible secondary treatment	Facilties available for chlorination
Brady	180			Lagoon	None	
Brockton	400	Missouri River	1746	Lagoon	None	
Browning	1,674	Willow Creek	2181-223-15	Septic tank	Lagoon	None
Cascade	447	Missouri River	2306	None	Lagoon	Preliminary planning initiated
Chester	733	Cottonwood Creek	---	Lagoon	None	

*Estimated

Municipality	1950 Census Population	Discharge to	Mileage	Treatment Provided	Additional Treatment Needed	Community Action
Chinook	2,299	Milk River	1857-363	Secondary & Chlorination	None	
Choteau	1,613	Teton River	2181-1.5-128	Lagoon	None	
Circle	856	No overflow	---	Lagoon	None	
Conrad	1,854	Pondera Creek	---	Lagoon	None	
Culbertson	779	No overflow from lagoon	---	Lagoon	None	
Cut Bank	3,719	Coulee to Cut Bank Creek	2181-200	Lagoon	None	
Denton	435	---	---	Lagoon	None	
Dillon	3,079	Beaverhead River	2464.4-65-27	Lagoon	None	
Dodson	330	Milk River	1857.4-258	Lagoon	None	
Dutton	431	Ditch		Secondary	None	
East Helena	1,214	Ditches to Prickly Pear Cr.	---	Lagoon	None	
Fort Belknap	200*	Milk River	1857.4-319	Septic tank	Lagoon	None
Fort Benton	1,508	Missouri River	2202	None	Lagoon	Under construction
Fort Harrison	300*	Seven Mile Creek	2372.5-9.4-5-2	Septic tank	Lagoon	Planning initiated
Fort Peck	1,150	Missouri River	1868	None	Lagoon	Construction to be started during 1960

*Estimated

Municipality	1950 Census Population	Discharge to	Mileage	Treatment Provided	Additional Treatment Needed	Community Action
Froid	555	Sheep Creek	1725.7-35-8	Small lagoon	Larger lagoon	Planning initiated for lagoon of proper size to serve complete community
Geraldine	374			Lagoon	None	
Glasgow	3,810	Milk River	1857.4-60	Lagoon	None	
Great Falls & Black Eagle	39,006	Missouri River	2248	None	Primary & Chlorination	Under construction
Great Falls - Malmstrom Air Force Base	4,000*	Missouri River	2245	Imhoff tank	Chlorination	None
Harlem	1,103	Thirty Mile Cr. to Milk River	1857.4-320-7	Secondary	None	Better operation required
Harlowton	1,718	Irrigation ditch to Musselshell River	1994.7-278	Lagoon	None	
Havre	8,094	Milk River	1857.4-401	Primary & chlorination	Secondary treatment probably needed	None
Helena	17,498	Prickly Pear and Ten Mile Creeks	2372.5-12	None	Primary & chlorination	Under construction
Helena - Vocational School	100*	Prickly Pear	2372.5-10	Lagoon	None	
Hingham	214	No overflow	---	Lagoon	None	

*Estimated

Municipality	1950 Census Population	Discharge to	Mileage	Treatment Provided	Additional Treatment Needed	Community Action
Hinsdale	350	Milk River	1857-121	Septic tank	Lagoon	None
Hobson	205	Judith River	2114.7-73	Lagoon	None	
Jordan	696	Big Dry Creek	---	Lagoon	None	
Judith Gap	175	Roberts Creek	---	Septic tank & sand filter	None	
Lavina	195	Musselshell River	1994.7-197	Septic tank	Chlorination	None
Lewistown	6,540	Big Springs Creek	2114-55-15	Primary	Plant expansion & chlortion	Planning initiated
Malta	2,085	Milk River	1857.4-215	Lagoon	None	
Manhattan	716	Gallatin River	2464-9	Septic tank	Lagoon	Construction to start during 1960 or 1961
Nashua	691	Milk River	1857.4-24	Septic tank	Lagoon	None
Medicine Lake	454	Big Muddy Creek	1725.7-55	Septic tank	Lagoon	None
Melstone	195	Musselshell River	1994.7-120	Lagoon	None	
Opheim	383	---	---	Lagoon	None	
Plentywood	1,862	Big Muddy	---	Lagoon	None	
Poplar	1,169	Missouri River	1775	Imhoff tank	Lagoon	None

*Estimated

Municipality	1950 Census Population	Discharge to	Mileage	Treatment Provided	Additional Treatment Needed	Community Action
Richey	595	No overflow	---	Lagoon	None	
Roundup	2,852	Musselshell River	1994.7-170	Lagoon	None	
Rudyard	550	No overflow	---	Lagoon	None	
Saco	539	Beaver Creek	1857-136.4	Septic tank	Lagoon	Planning initiated
Scobey	1,628	Poplar River	1775.8-95.1	Imhoff tank	Lagoon	Planning initiated
Shelby	3,058	Ditch to Marias River	2181-164	None	Lagoon	Under construction
Sheridan	572	Mill Creek	2464.4-65-4	Lagoon	None	
Stanford	542	Skull Creek	2114-10.5-60-2	Septic tank & sand filter	Lagoon	None
Sunburst	845	Pond with no outlet	---	Septic tank	None	
Three Forks	1,106	Jefferson River	2464.4-3.4	None	Lagoon	Construction to star during 1960 or 1961.
Townsend	1,316	Missouri River	2423	Lagoon	None	
Trident	200	Missouri River	2463	Septic tank	Lagoon	None
Twin Bridtes State Children's Home	350*	Beaverhead River	2464.4-65-4	Lagoon	None	

*Estimated

Municipality	1950 Census Population	Discharge to	Mileage	Treatment Provided	Additional Treatment Needed	Community Action
Valier	710	Dry Creek	---	Lagoon	None	
Vaughn	125*	Sun River	2252.2-12	Imhoff tank	Chlorination	None
Whitehall	929	Whitetail Creek	2464.4-40-3	Septic tank	Lagoon	Construction should start during 1960
White Sulphur Springs	1,015	Smith River	2280.4-115-5	Lagoon	None	
Winnett	407	McDonald Creek	1994.7-67-20-15	Septic tank	Lagoon	None
Wolf Point	2,557	Missouri River	1800	Lagoon	None	

*Estimated

TABLE 3*

Status of Major Industrial Wastes Treatment
in Missouri River Basin of Montana

Location	Name	Discharge to	Mileage	
Bozeman	Vollmer Slaughter House	E. Gallatin	2464-10-32	Treatment inadequate.
Chinook	Diamond Asphalt Company			No discharge to creek.
Cut Bank	Union Oil Company			Treatment adequate - no wastes reach flowing water course.
Great Falls	A.C.M. Reduction Plant	Missouri River	2248	No apparent detrimental effects to Missouri River by effluent discharge.
Great Falls	Phillips Oil Refinery	Missouri River	2248	Treatment probably inadequate. Further study needed. Discharge to Missouri River.
Great Falls	Great Falls Meat Packing Co.	Missouri River	2246	Discharge untreated wastes to Missouri River. Need treatment facilities.
Great Falls	Montana Meat Company			Wastes treated in non-overflowing lagoons.
Great Falls	Great Falls Brewery			Wastes to city sewer.
Kevin	Big West Refinery			Treatment adequate-no wastes reach flowing water course.
Sunburst	Texaco Refinery			Treatment adequate-no wastes reach flowing water course.
Townsend	Northern Mills	Indian Creek	2423-12	Discharge to Indian Creek. Need adequate settling ponds.

*It is required that a permit be obtained before a waste is discharged to a classified stream. Those that are now discharging wastes will have their operations reviewed periodically.

SURVEY INFORMATION PROVIDED

The location and identification of the stations are shown in Appendix A. The river mileages indicated were obtained from U. S. Geological Survey (USGS) data where available or in other instances where USGS river mileages were not available, the mileage was estimated from the closest point that a USGS mileage was provided. Maps 1, 2 and 3 give the location of the stations in conjunction with Appendix A.

Bacteriological, chemical and physical data are listed in Appendix B and biological data in Appendix C. Again, the stations can be located by referring to Appendix A and Maps 1, 2 and 3.

In general, sampling stations were located as follows:

1. Above and below known sources of pollution being discharged into the stream, with the "below pollution" being located far enough downstream from the effluent to insure thorough mixing with the receiving stream.

2. Above and below the mouth of an entering stream.

3. At various locations in streams known to be free of municipal and industrial pollution.

Ideally samples would be taken at various times throughout the year at each station and a 24 hour composite or individual samples over a period of 24 hours would be taken. Due to personnel available and budget considerations, the ideal could not be accomplished. However, in a few instances where it appeared that dissolved oxygen might be a problem in supporting fish life, dissolved oxygen samples were collected over a 24 hour period and analyzed. Samples for bacteriological examination and biochemical oxygen demand (BOD) were normally taken over a 24 hour period at the same time 24 hour dissolved oxygen samples were taken. At a small number of stations, samples were collected both during 1958 and 1959.

It is preferable where only one sample is taken, that the sample be taken when the stream is being taxed at its maximum. This generally occurs at a time when the flow is at its lowest. Sampling at such a time in most instances was not possible because of the availability of the survey crew only during the summer months. During June and the earlier part of July stream flows are generally close to the maximum. It should, therefore, be recognized that single grab samples for bacteriological, physical and chemical analysis represent only conditions at the time of the sample collection and wide variation from these results at other times could occur. The biological results would not have the wide seasonal variation experienced in chemical and bacteriological results.

Chemical data in most instances during this survey did not provide much information on pollution. Low dissolved oxygen samples would indicate gross pollution. The Most Probable Number (MPN) of coliform bacteria gives a good indication of municipal pollution while biological results are usually the best indicator of industrial pollution and to some extent human sewage pollution.

A report, "Pollution Studies on the Missouri River in the Great Falls Area" dated November 26, 1957 and published by the Montana State Board of Health gives further chemical, physical, bacteriological and biological data for the immediate Great Falls area.

CHEMICAL AND PHYSICAL PROCEDURES AND RESULTS

In the selection of the chemical data to be obtained, the object was to complete the majority of the tests in the field and the time consumed on these chemical tests approximated the time spent on the biological work and as much data as possible was obtained in this period of time.

Additional and more complete chemical analyses can be obtained from the Quality of Water Branch of the U. S. G. S. for the Gallatin River Basin, Beaverhead River, Madison River, Missouri River, Prickly Pear Creek, Sun River, Cut Bank Creek, Marias River, and Milk River.

Dissolved Oxygen

Dissolved oxygen analysis is the one chemical test known to be invaluable in pollution control work as it is indicative of organic pollution. Biological life in the streams use oxygen in their process of purifying this organic waste. Since the action of the biological life in purifying the waste is a comparative slow process, the point of lowest dissolved oxygen content (oxygen sag) may be many miles downstream from the source of pollution.

Dissolved oxygen analytical procedures followed the modified Winkler Method using the Alsterberg Modification as set forth in "Standard Methods for the Examination of Water, Sewage and Industrial Wastes", 10th Edition.

Dissolved oxygen results are expressed in parts per million (ppm) and percent saturation. Five ppm of dissolved oxygen is considered necessary to support a game fish population such as rainbow trout and is the minimum permitted by the Water Pollution Council Criteria. Percent saturation gives a better indication of organic pollution as saturation of dissolved oxygen varies with water temperature and barometric pressure. Barometric pressure varies with elevation and weather conditions. At sea level dissolved oxygen saturation ranges from 14.6 ppm at 32° F. to 9.2 ppm at 68° F. At constant temperature, saturation is decreased approximately 1% for each 270 foot rise in the elevation above sea level. For example saturation on the Beaverhead River near Dillon (elevation 5400 feet) at 68° F. would be 7.5 ppm while the Missouri River near Culbertson (elevation 1900 feet) would have a saturation value of 8.5 ppm at the same temperature. In this report saturation values have been computed using temperature and elevation corrections according to "Standard Methods for the Examination of Water, Sewage, and Industrial Wastes", 10th Edition.

Unfortunately, of any of the chemical results determined, dissolved oxygen is subject to the greatest daily and hourly variation. It is possible to have greater than saturation values (super saturation) during daylight hours and a large decrease from saturation during the night at the same station. This phenomenon is mainly the result of active photosynthesis

by aquatic plants, particularly algae. These plants during the day give off oxygen as a by-product and during the night use oxygen. Normally, the heavier the organic pollution load, the greater the number of aquatic plants, and, therefore, the greater the variation of dissolved oxygen in the stream. Since the survey work was usually conducted during daylight hours, the dissolved oxygen values are probably close to the maximum for that day.

Dissolved oxygen sampling over a 24 hour period was conducted below Bozeman on Bozeman Creek (Table 5) and the East Gallatin River (Tables 6 and 7); below Great Falls on the Missouri River at Rainbow Dam (Table 8); at Fort Benton (Table 9), and at Virgelle (Table 10); below Lewistown on Big Spring Creek (Table 11) and on the Judith River (Table 12). At these stations it was indicated that dissolved oxygen might be critical in the support of a game fish population.

There were only two sampling stations that indicated dissolved oxygen below 5 ppm, the East Gallatin River below the City of Bozeman sewage treatment plant discharge (Station #36) and Whitetail Creek below the Town of Whitehall sewage discharge (Station #22). Whitehall's sewage treatment facilities will be constructed during 1960 which should eliminate the low oxygen conditions on Whitetail Creek. The City of Bozeman sewage treatment plant has chlorination facilities which are not presently used. Addition of chlorine to the Bozeman sewage treatment effluent should decrease the organic load placed on the East Gallatin River a small amount. A much greater reduction of loading on the East Gallatin River would be obtained by the proper treatment of wastes from the Vollmer Slaughterhouse located a short distance above the sewage treatment plant. An inspection was made by a State Board of Health engineer at this plant during December, 1959 and treatment procedures were recommended to the owners.

From data in the State Board of Health files, another known zone of low dissolved oxygen during part of the summer months is Prickly Pear Creek below the City of Helena sewage outfall. The Helena sewage treatment plant should be placed into operation during 1960 which should help to eliminate the nuisance conditions in Prickly Pear Creek.

Alkalinity, Hardness, Chlorides, Sulfates, and pH

The chemical information given by the survey results for alkalinity, hardness, chlorides, sulfates, and pH may have little pollution control value except for industrial wastes, but is of much interest to direct users of the waters. An industry dependent upon water from a surface supply must know its chemical constituents as must a municipality taking the water for its water supply. Fisheries workers use chemical data in comparting streams in their relationship in supporting of fish life. The chemical data, although not a complete analysis, is of value to these people.

From Appendix B it can be noted that there are a considerable number of pH (hydrogen ion concentration) results indicating a pH of greater than 8.5 and the results range from 7.1 on Prickley Pear Creek (Station 47) and Carpenter Creek (Stations 65 and 67) to a high of 9.0 on Alder Creek (Station 13), Cut Bank Creek (Station 79) and Big Muddy Creek (Station 145).

The Water Pollution Council has accepted a pH range of 6.5 to 8.5 for Class A, B, C and D waters, that is, waters used as a source for domestic supplies, recreation, and fish and game. On the Missouri River drainage pollution is not indicated as the cause of pH values above 8.5. The actual damage to a stream by a pH higher than 8.5 is not known, but there are some reports in the literature that game fish may be restricted. This is particularly true in instances where there is a rapid change to the higher pH, such as, a sudden large discharge by an industry of an alkaline waste.

Chlorides will indicate sewage pollution if the ratio of sewage to dilution water is high, as there is a high concentration of chlorides in sewage. Normally, the small increase in chlorides in a stream after sewage is discharged in itself is not harmful to the stream. Conventional sewage treatment does not decrease the chloride content. An increase in chlorides can be readily noted in Whitetail Creek below Whitehall. This would indicate very little dilution water for the sewage. Chlorides may also indicate pollution from oil fields as water with a high chloride content is sometimes pumped from an oil well along with the oil. Several years ago the Poplar River received high chloride wastes from nearby oil fields. This pollution has since ceased and the wastes are now either evaporated or injected into deep wells that are no longer used for oil production.

Of course, there are other industries that might discharge large concentrations of chlorides as well as large concentrations of sulfates, alkalinity, hardness, etc. However, in the Missouri River Drainage Basin there does not appear to be any significant increase of any of these chemical constituents from industrial discharges and these chemical results are probably of interest only to the fisheries workers, industries, municipalities, etc. and they will not be discussed further in this report because of their doubtful pollutional significance.

The chloride analysis was done by the Mohr method, sulfates by the Tetrahydroxyquinone indicator method, hardness by the Versenate method, and alkalinity by the brom-cresol green-methyl red indicator method.

Copper, Iron, Lead, Zinc, and Arsenic

Copper, iron, lead, zinc, and arsenic analyses were completed on samples from Carpenter Creek (Stations #64 and 67) and Snow Creek (Station #66) in the vicinity of Neihart. This is an area of former and possible future mining and milling activity and it was desired to learn the present effects on the stream from old tailings ponds. The concentration of iron and zinc in Carpenter Creek and zinc in Snow Creek might possibly restrict some varieties of fish life. These analyses were made in the State Board of Health chemical laboratory.

Temperature

Stream temperature data is provided as this information is needed to calculate dissolved oxygen saturation values. Temperature is also important to stream fisheries workers. Water temperatures were observed using a Taylor pocket thermometer.

Turbidity

The turbidity of water is attributable to suspended and colloidal matter, the effect of which reduces clearness and the penetration of light. The turbidity of the water sample is a measure of the extent to which the intensity of light penetration is reduced by suspended or colloidal matter. The standard unit of turbidity is considered as that produced by one part per million of silcia in distilled water. High stream turbidities can be produced by natural runoff, improper irrigation practices and overgrazing, aquatic life such as algae, gravel washing operations, milling operations, etc. The important game fish species in Montana, such as trout, salmon, whitefish, and bass require clean water and increasingly turbid water reduces the numbers of these fish if the turbidity is of permanent nature. Other fish species, such as sheepshead, catfish and carp seem to thrive in turbid waters. The bottom food organisms for the fish can also be reduced by a layer of sediment on the stream bottom. The high turbidity at Station #47 on Prickly Pear Creek is a good example of industrial pollution. At the time of the stream survey a gold dredge was operating between Stations #46 and #47 with small settling ponds preceding Station #47. The gold dredge has since ceased operation and the stream has apparently returned to normal.

Turbidities except where indicated in Appendix B were determined in the field with a U. S. Geological Survey model turbidity tape. On a small number of samples, turbidities were determined in the State Board of Health Chemical Laboratory with a Model B Beckman Spectrophotometer calibrated using a Jackson Candle.

Stream Flow Data

Stream flow measurements were obtained from USGS gaging stations on the main stem of the Missouri River, Big Hole River, Jefferson River, Gallatin River, East Gallatin River, Marias River, Musselshell River and Milk River. At stations where USGS flows were not available, stream flows were determined by the field crew with a current meter supplied by the USGS. In some instances in Appendix B stream flows are shown as estimated. In these cases the flows were estimated from USGS gaging stations or from flows measured by the survey crew at some distance from the station.

Critical conditions, as far as pollution is concerned, normally occurs during low flows. Table 4 lists hydrologic data obtained from USGS literature at various gaging stations throughout the Missouri Basin in Montana.

TABLE 4

Hydrological Data (Tabulated from data provided in USGS Water-Supply Paper 1509, 1957 Part 6-A)

River & Station	Approximate Stream Mileage Index[1]	Period of Record	Average Discharge for Period of Record. cfs	Extremes Maximum cfs	Date	Minimum cfs	Date
Beaverhead River at Blaine	2464.4-81	1935-1957	397	3,130	6-12-44	7.0	5-25-40
Big Hole River near Melrose	2464.4-89	1924-1957	1,129	14,100	6-3-48	49	8-17-31
Whitetail Creek near Whitehall	2464.4-40-13	1949-1953 1955-1957		126	5-18-51	0.8	11-15-51
Jefferson River near Sappington	2464.4-18	1896-1905 1938-1957	2,131	21,000	6-23-99	134	8-12-40
Madison River near McAllister	2464.4-30	1938-1957	1,612	7,750	6-2-43	409	4-27-41
*East Gallatin River near Bozeman	2464-10-31	1939-1959	86	1,240	6-4-53	12	12-9-44 3-24-55
Bridger Creek near Bozeman	2464-10-30.5-3	1946-1957	34	902	6-3-53	0.9	3-23-53
Gallatin River near Logan	2464-5	1895-1898 1902-1905 1928-1932 1934-1957	949	7,870	6-5-48	130	7-19-39
Missouri River at Toston	2438	1941-1957	5,049	32,000	6-6-48	562	4-30-41
Prickly Pear Creek near Clancy	2372.5-25	1945-1953 1954-1957	45	586	6-5-48	2.3	2-4-55

[1]Estimated using USGS mileage index
*Data obtained from Helena USGS Office

Table 4, Continued

River & Station	Approximate Stream Mileage Index[1]	Period of Record	Average Discharge for Period of Record. cfs	Extremes Maximum cfs	Date	Minimum cfs	Date
Missouri River below Holter Dam	2340	1945-1957	5,182	34,800	6-8-48	830	5-22-55
Sun River near Vaughn	2252.2-12	1934-1957	712	17,900	6-4-53	21	5-10-41
Missouri River near Great Falls	2235	1956-1957		18,700	6-11-57	2,470	12-5-56
Belt Creek near Monarch	2234.2-25	1951-1957	152	11,000	6-4-53	2	1-3-57
Missouri River at Fort Benton	2202.9	1890-1957	7,613	140,000	6-6-08	627	7-5-36
Cut Bank Creek at Cut Bank	2181-201	1951-1957	235			5	12-28-54
Marias River near Shelby	2181-168	1902-1908 1911-1957	950	40,000	6-18-48	10	8-20-19
Teton River near Dutton	2181-1.5-50	1954-1957		1,100	5-23-57	20	1-24-57
Big Spring Creek near Lewistown	2114.7-55-22	1932-1957	107	250	5-30-53	76	2-1-38
Musselshell River near Harlowton	1994.7-281	19-7-1957	149	4,530	6-24-38	0	Several Dates
Musselshell River near Roundup	1994.7-172	1931-1932 1945-1957	184	4,790	6-19-48	0	Several Dates

[1] Estimated using USGS mileage index

Table 4, Continued

River & Station	Approximate Stream Mileage Index[1]	Period of Record	Average Discharge for Period of Record. cfs	Extremes Maximum cfs	Date	Minimum cfs	Date
Musselshell River at Mosby	1994.7-60	1929-1932 1934-1957	228	18,000	6-18-44	0	Several Dates
Missouri River below Fort Peck	1864	1943-1957	9,861				
Milk River at Nashua	1857.4-26	1939-1957	750	45,300	4-18-52	4.6	4-18-46
Poplar River near Poplar	1775.8-8	1948-1957	175	37,400	4-6-54	0	Several Dates

[1] Estimated using USGS mileage index

TABLE 5

Bozeman Creek below Bozeman

Station No. 33
August 19 and 20, 1959

Time	Flow cfs[1]	Temperature Degrees F.	Dissolved Oxygen ppm.	Dissolved Oxygen % Saturation	B.O.D. ppm	MPN Coliform bacteria per 100 ml.
7 A.M.		51	8.4	89	2.2	2,300,000
10 A.M.		54	8.8	97	6.4	
11 A.M.						4,300,000
1 P.M.		57	8.8	100	9.4	
3 P.M.						2,300,000
4 P.M.		60	8.2	97	8.0	
7 P.M.		57	6.2	70	4.2	430,000
10 P.M.		57	6.4	73	7.0	
11 P.M.						930,000
1 A.M.		54	7.2	79	5.0	
3 A.M.						75,000
4 A.M.		52	7.6	81	3.4	
7 A.M.		51	8.0	85	3.4	150,000

[1]No flow data available

TABLE 6

East Gallatin River Below Bozeman

Station No. 36
July 7, 1959

Time	Flow cfs[1]	Temperature Degrees F.	Dissolved Oxygen ppm.	Dissolved Oxygen % Saturation	B.O.D. ppm	MPN Coliform bacteria per 100 ml.
7 A.M.		51	7.8	83	1.8	
10 A.M.		52	8.0	85	4.2	
1 P.M.		51	7.6	80	4.3	
4 P.M.		50	6.8	71	8.1	
7 P.M.		48	7.8	80	7.7	

NOTE: This survey was halted due to an erratic rise in water level caused by heavy rain. Due to the relatively high B.O.D., it was re-run on August 19.

[1]No flow data available

TABLE 7

East Gallatin River Below Bozeman

Station No. 36
August 19 and 20, 1959

Time	Flow cfs[2]	Temperature Degrees F.	Dissolved Oxygen ppm.	Dissolved Oxygen % Saturation	B.O.D. ppm.	MPN Coliform bacteria 100 ml.
7:30 A.M.		54	6.8	75	4.0	23,000,000
10:30 A.M.		58	8.2	95	4.6	
11:30 A.M.						4,300,000
1:30 P.M.		61	7.0	83	12.0	
3:30 P.M.						4,300,000
4:30 P.M.		61	7.4	88	6.7	
7:30 P.M.		59	5.4	62	5.6	930,000
10:30 P.M.		55	4.8	53	6.4	
11:30 P.M.						930,000
1:30 A.M.		56	5.2	58	5.6	
3:30 A.M.						930,000
4:30 A.M.		53	6.0	65	4.8	
7:30 A.M.		54	7.0	77	3.6	930,000

[2]Flow at USGS gaging station on East Gallatin River above Bridger Creek averaged 48 cfs during this survey. The gaging station is located above Bridger Creek and the flow at Station No. 36 would be greater.

TABLE 8

Missouri River at Rainbow Dam

Station No. 61
August 4 and 5, 1959

Time	Flow cfs	Temperature Degrees F.	Dissolved Oxygen ppm.	Dissolved Oxygen % Saturation	B.O.D. ppm.	MPN Coliform bacteria 100 ml.
7 A.M.	4,570	63	6.6	75	2.9	9,300
10 A.M.	4,430	64	7.2	85	2.3	23,000
1 P.M.	4,430	65	7.8	91	2.9	2,300
4 P.M.	4,430	65	9.0	106	2.7	4,300
7 P.M.	3,290	68	9.4	115	2.7	4,300
10 P.M.	4,570	64	9.0	105	2.4	2,300
1 A.M.	4,570	63	7.6	87	3.2	23,000
4 A.M.	4,570	62	7.0	79	2.6	23,000
7 A.M.	4,570	63	7.0	80	2.9	15,000

TABLE 9

Missouri Above Fort Benton

Station No. 73
July 27, 28, and 29, 1959

Time	Flow cfs	Temperature Degrees F.	Dissolved Oxygen ppm.	Dissolved Oxygen % Saturation	B.O.D. ppm.	MPN Coliform bacteria per 100 ml.
6 P.M.	8,500	64	8.8	100	1.6	9,300
9 P.M.	5,180	63	8.4	95	0.6	4,300
12 M	3,340	62	7.0	78	1.7	2,300
3 A.M.	5,390	60	6.4	70	1.4	1,500
6 A.M.	5,240	63	7.4	84	1.1	2,300
9 A.M.	2,750	64	8.6	100	1.0	2,300
12 N	1,850	65	8.4	97	1.5	230
3 P.M.	1,810	65	8.6	100	2.7	430
6 P.M.	8,260	68	8.6	105	1.6	4,300
9 P.M.	4,940	64	8.0	92	2.1	930
12 M	3,270	63	7.6	85	1.2	2,300
3 A.M.	4,760	62	7.4	83	1.7	2,300
6 A.M.	5,540	63	7.4	85	2.1	2,100

TABLE 10

Missouri River at Virgelle

Station No. 90
August 11 and 12, 1959

Time	Flow cfs	Temperature Degrees F.	Dissolved Oxygen ppm.	Dissolved Oxygen % Saturation	B.O.D. ppm.	MPN Coliform bacteria per 100 ml.
6 A.M.	7,690	65	7.6	88	1.7	390
9 A.M.	6,480	66	8.2	95	1.6	930
12 N	5,840	69	9.6	116	1.6	430
3 P.M.	6,480	71	9.6	119	1.8	150
6 P.M.	6,480	70	9.4	114	2.2	93
9 P.M.	5,240	67	8.6	102	1.6	150
12 M	4,380	66	8.2	95	1.6	390
3 A.M.	5,120	65	7.7	90	1.6	230
6 A.M.	7,130	63	8.0	90	1.4	430

TABLE 11

Big Spring Creek Above the Judith River

Station No. 99
June 23 and 24, 1959

Time	Flow cfs	Temperature Degrees F.	Dissolved Oxygen ppm.	Dissolved Oxygen % Saturation	B.O.D. ppm.	MPN Coliform bacteria per 100 ml.
8 A.M.		60	7.6	85	2.0	
11 A.M.		62	8.6	98	1.4	
2 P.M.		66	9.0	108	1.5	
5 P.M.	254	67	7.7	94	1.5	
8 P.M.		66	9.2	110	1.1	
11 P.M.		65	7.3	87	3.4	
2 A.M.		64	7.5	88	1.0	
5 A.M.		62	7.3	84	1.0	
8 A.M.		60	7.9	87	1.0	4,300

TABLE 12

Judith River Below Big Spring Creek

Station No. 100
June 23 and 24, 1959

Time	Flow cfs	Temperature Degrees F.	Dissolved Oxygen ppm.	Dissolved Oxygen % Saturation	B.O.D. ppm.	MPN Coliform bacteria per 100 ml.
8 A.M.		60	6.0	67	1.3	
11 A.M.	667	62	8.6	97	1.3	
2 P.M.		66	7.3	89	1.2	
5 P.M.		67	7.3	90	0.8	
8 P.M.		64	7.1	83	1.0	
11 P.M.		66	7.3	88	2.3	
2 A.M.		64	6.9	80	1.1	
5 A.M.		62	7.7	88	1.0	
8 A.M.		62	7.9	90	1.0	750

BACTERIOLOGICAL PROCEDURES AND RESULTS

The measuring stick used for determining the pathogenic safety of a water is the bacteriological analysis. Water samples were collected by the stream pollution survey team in sterile bottles and returned to the State Board of Health Bacteriological Laboratory for determination of the most probable number (MPN) of coliform organisms. The coliform organism is present in the intestional tract of man and other warm blood animals in large concentrations and its presence in water is evidence of fecal contamination.

The coliform bacteria themselves are harmless, but the minute number of disease organisms in a water make their isolation unreliable if not impossible. It is, therefore, necessary to test for organisms associated with disease producers that are present in polluted waters in large numbers. For this reason the coliform bacteria has been selected as the indicator of pollution in standard water tests.

Maximum allowable MPN values have been set by the Montana Water Pollution Council for the various stream classifications and are shown in Appendix E.

In the Missouri Basin there are seven municipal supplies using Class B waters, but are using treatment as if they were Class A. They are Bozeman (Bozeman and Hyalite Creek supplies), Butte (Big Hole River supply), Brady, Conrad (Lake Francis supply), Culbertson, East Helena and Helena (Ten Mile Creek Supply). The areas above these supplies are subject to contamination. This is true particularly of Culbertson which takes its water from the Missouri River and municipal sewage discharges enter the river above their water intake from such cities as Poplar.

Extensive sampling has been done at Fort Benton and the results of one 24 hour sampling period are shown in Table 11. The MPN results vary from 230 to 9,300. In 69% of the samples the MPN has exceeded the 2,000 MPN limit set by the Water Pollution Council for a Class B water supply. Routine samples have shown results as high as 28,000. The high MPN count is mainly due to the City of Great Falls sewage discharges. This condition should be eliminated during late 1960 when the Great Falls sewage treatment plant is placed into operation.

The communities of Chinook, Harlem, and Fort Belknap take water from the Milk River for their domestic water supplies. The Milk River at their water intakes exceeds the limits for a Class B water supply. The City of Havre sewage treatment plant appears to be improperly chlorinating the sewage effluent.

The MPN also exceeds the limits set for a Class C water at the following stations:

Station 9, Beaverhead River below Dillon. The reason for the relatively high MPN figure is not known. The City of Dillon has a sewage lagoon which should reduce the MPN value of the lagoon effluent to a figure

approximately equal to that found in the river itself during the summer. It is possible that there are individual sewer lines discharging in the vicinity of the sampling station. This result should be further checked and additional samples taken.

Station 16, Beaverhead River above Twin Bridges. The high result during 1959 was probably due to individual sewage discharges and/or cattle. A sample taken during 1958 was acceptable for a Class C water.

Station 17 and 18, Beaverhead River below Twin Bridges Children's Home and Town of Twin Bridges. High results are presumed to be due to sewage discharges. Since the time of the sample, the State Children's Home at Twin Bridges has placed into operation a sewage lagoon system. However, the Town of Twin Bridges has some private sewers discharging into the river. The town defeated a bond proposal during 1960 for a complete sewer system and sewage treatment facilities.

Station 22, Whitetail Creek below Whitehall. Sewage treatment facilities are scheduled to be constructed during 1960 to eliminate the high MPN value at this station.

Station 25, Jefferson River above Three Forks. The MPN value although not greatly exceeding the Class B water limits, is probably due to Whitehall sewage.

Station 26. Jefferson River below Three Forks. Sewage treatment facilities will be constructed by the City of Three Forks during 1960 or 1961 which should eliminate the high value.

Station 30. East Gallatin River above Bozeman. Several individual sewers probably enter the river in this area. This should be investigated further. Local action is probably needed.

Station 32. Bozeman Creek above Bozeman. It is possible that individual sewer discharges enter the creek in this area. Further investigation is needed.

Station 33. Bozeman Creek below Bozeman. One of the Bozeman city sewers crossing Bozeman Creek was found by the stream survey crew to be broken and has since been repaired. Several individual sewers are known to discharge to Bozeman Creek above this station. Twenty-four hour sampling was done at this station. (See Table 5).

Station 34. East Gallatin River below Bozeman Creek and above Bozeman sewage treatment plant effluent. Part of contamination is due to sewage received by Bozeman Creek. Also the Vollmer Slaughterhouse wastes enter above this station along with individual sewer discharges.

Station 35. Bridger Creek. Several individual sewers probably discharge above this point.

Stations 36, 37 and 38. East Gallatin River below Bozeman. Main sewage discharge is treatment plant effluent from the City of Bozeman. Sewage

effluent is not presently chlorinated, but facilities are available for chlorination. A twenty-four hour sampling schedule was carried out at Station 36. (See tables 6 and 7).

Station 40. Gallatin River near Logan. This station is below the Town of Manhattan sewage discharge. Manhattan has had a successful election for sewage treatment facilities and construction should begin during 1960 or 1961.

Station 41. Missouri River above Trident. This station is near the head of the Missouri River. The City of Three Forks discharges sewage to the Jefferson River a short distance above this station.

Station 42. Missouri River below Trident. This station is located a short distance below the Trident sewage discharge. The community of Trident needs more effective treatment of its sewage.

Another known location of high MPN values is on Ten Mile Creek and Prickly Pear Creek below the City of Helena sewage discharges. Values ranged between 68,000 and 1,265,000 on Ten Mile Creek and between 68,000 and 22,000,000 on Prickly Pear Creek on samples taken during the spring of 1958. After the Helena sewage treatment plant is placed into operation in 1960, all the treated sewage will be discharged to Prickly Pear Creek and the outfall to Ten Mile Creek will be eliminated.

Station 61. Missouri River at Rainbow Dam Forebay. This station is below the City of Great Falls sewer outfall lines. Treatment facilities should be placed into operation during late 1960. Twenty-four hour sampling was done at this station. (See Table 8).

Station 73. Missouri River above Fort Benton. This station is approximately 40 miles below the City of Great Falls. Twenty-four hour sampling was done at this station. (See Table 9).

Station 90. Missouri River at Virgelle. Although this station is over 80 miles below Great Falls and 40 miles below Fort Benton, the effects of the municipal sewage discharges can still be noted. (See Table 10). Both Great Falls and Fort Benton should have their new sewage treatment facilities in operation by early 1961.

Station 95. Judith River above Big Spring Creek. The MPN value is probably indicative of contamination from cattle, etc. Further sampling is needed at this station.

Stations 97,98, and 99. Big Spring Creek below Lewistown. Lewistown has a conventional primary treatment plant which is overloaded. The high MPN value indicates the need of rehabilitation of the plant and use of chlorination facilities.

Station 100. Judith River below Big Spring Creek. This sample had a lower MPN value than the above Big Spring Creek Station which would indicate an error in the sample from Station 95. The MPN value at Station 100 probably is due to the Lewistown sewage discharge.

Stations 118 and 119, Milk River below Havre. The City of Havre has a conventional primary treatment plant with chlorination facilities. Chlorine is used as a disinfectant, but in insufficient amounts. During 1960 the State Board of Health has completed further tests at the Havre sewage treatment plant in order to recommend proper chlorine dosages.

Stations 123 and 124. Milk River below Chinook. High MPN values are probably more indicative of pollution from the City of Havre than the City of Chinook. Chinook has secondary sewage treatment and chlorinates the sewage effluent.

Stations 125 and 126. Milk River below Harlem. This station is probably again indicative of pollution mainly from the City of Havre. The Town of Harlem has a poorly maintained secondary sewage treatment plant, but does not chlorinate the sewage effluent.

Station 128. Milk River above Malta. There is probably still some contamination at this point from sewage discharges from Havre, Chinook and Harlem. Dodson now has a sewer system and an effective sewage treatment plant.

Station 129. Milk River below Malta. The City of Malta placed into operation their sewage lagoon system during 1959 which will eliminate the high MPN value reported during 1958.

Stations 133 and 134. Milk River below Hinsdale. The Town of Hinsdale has only a septic tank for sewage treatment. Recommendations have been made to the Town for additional treatment facilities.

Stations 135 and 136. Milk River below Glasgow. The City of Glasgow placed their sewage lagoon facilities into operation during 1960 which will reduce the high MPN values obtained during 1958.

Station 137. Milk River below Nashua. The sample from this station indicates the present septic tank is ineffective and further treatment is needed by the Town of Nashua.

Station 140 and 141. Missouri River below Wolf Point. The City of Wolf Point placed their sewage lagoon into operation during 1959 which will greatly decrease the MPN value in the river.

Station 142. Poplar River above Poplar. The reason for the high MPN value at this station is not known.

In all of the above sampling it should be recognized that at most stations, only single grab samples were taken and the drawing of conclusions from this single grab sample may at sometimes be misleading.

BIOLOGICAL PROCEDURES AND RESULTS

Aquatic macro-invertebrates have for some time been a recognized method of evaluating organic and inorganic pollution. The term "biological" evaluation would in a true sense refer to an evaluation of the entire biological complex of an aquatic environment. Its use here, however, is restricted to those relatively large organisms referred to as macro-invertebrates. These organisms are all members of the animal kingdom, are usually found on the stream bottom, and are visible and possible to identify, at least into broad groups, with the unaided eye. The most frequently encountered aquatic macro-invertebrates are the larvae, nymphs, and in some cases adults of aquatic insects. Some of the less frequently encountered forms are the flatworms, roundworms, aquatic earthworms, snails, leeches, and fresh-water shrimps.

In this study, aquatic macro-invertebrates were collected with a four-square-foot sampler. This equipment consisted of a square metal frame measuring two feet on each side, and a three-by-four-foot hand screen constructed of common window screen (approximately 14 meshes to the inch) with one inch dowelling for handles. The four-square-foot frame is embedded in the stream bottom and the hand screen is held immediately downstream from this frame. The stream bottom within the four-square-foot frame is disturbed with the operator's feet which dislodges the bottom-dwelling organisms. The stream current carries the organisms onto the screen. After this, the screen is carefully removed from the water, carried to the stream bank, and placed on a white sheet of oilcloth. The organisms are "picked" from the screen (and the oilcloth in the case of those organisms that fall through the screen), sorted to type, counted, and placed in a preservative of either 70 percent alcohol or 5 percent formalin for future reference.

Whenever possible samples were collected in a riffle area of the stream being sampled. Ordinarily, the greatest diversity of macro-invertebrates are found in this type of habitat.

Except for reconnaissance samples for which no figures are listed, at least four square feet of stream bottom were sampled at each station.

Aquatic macro-invertebrates lend themselves as pollution indicators because of the presence or absence of certain forms in polluted aquatic environments. The presence of some forms and the absence of others in a polluted environment is due to anatomical structures and physiological differences that exist between the various types. Organic pollution such as sewage may depress the available dissolved oxygen supply of a stream section, cover the stream bottom with settleable solids (sludge), or may cause the growth of other organisms that cover the stream bottom. This in effect creates an environment suitable only for those organisms capable of existing on a low amount of dissolved oxygen, or possessing structures that enable them to obtain oxygen from the atmosphere. In many cases such organisms must also be capable of living on a sludge bottom. Organic pollution enriches the aquatic environment and as a result a great amount of food is available for those organisms able to withstand low dissolved oxygen and sewage sludge. Therefore, such organisms multiply rapidly and are usually found in great numbers. Those organisms which require a relatively high dissolved oxygen content and a firm stream substrate are unable to compete, and thus their numbers are either greatly reduced, or they are absent entirely.

Under normal "clean" water conditions the macro-invertebrate population of a stream will consist of many different species, but only a few individuals of each species. Under organically polluted conditions the macro-invertebrate population will consist of a few species, but a great many individuals of each species present.

Inorganic pollution, if it is severe, usually has a lethal effect upon the entire macro-invertebrate population. Where gross inorganic pollution is found, the stream bottom is usually devoid of animal life. Organic pollution when severe, alters the species composition of the macro-invertebrate population.

Those macro-invertebrates that can withstand gross organic pollution are called "insensitive organisms" -- that is, they are not effected by organic pollution. Those that cannot withstand the effect of organic pollution are called "sensitive organisms."

The important and most numerous macro-invertebrates collected during this survey were identified to Order. Some of the less important and less numerous forms were identified to Class. One form, the parasitic roundworms, were identified only to Phylum. Identification was made in the field. Although this is subject to some error, it was considered accurate enough for a survey of this type.

Those macro-invertebrates that are generally considered sensitive to pollution are the Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies), and the Odonata (damsel and dragonflies).

Those macro-invertebrates generally considered insensitive to pollution, include the Coleoptera (beetles), Oligochaeta (aquatic earthworms), Hirundea (leeches), Gastropoda (snails, at the least the pulmonate types), Amphipoda (side swimmers), Hemiptera (true bugs), Turbellaria (the common fresh-water flatworm), Isopoda (sow bugs), Nematoda (roundworms) and the Arachina (mites).

Representatives of all of these groups were collected in the Missouri River Drainage during this survey. See Appendix C.

This breakdown of organisms into sensitive and insensitive groups is not in its entirety satisfactory. It is well known that some species found within the above groups are not representative of the entire group in their ability to withstand or not to withstand, the effects of organic pollution. But, specific information relative to the degree of organic pollution that most individual species can withstand is lacking, and identification to the species level is both costly and time-consuming.

For the purpose of this report a rather simple method was employed in the analysis of the biological data. This method, generally referred to as the "Percent Sensitive Method", consists of computing the percent sensitive organisms in the samples at any given sampling station. Although commonly used, this method lends itself to some degree of error. To arbitrarily choose a certain percentage as the dividing line between polluted and non-polluted stations could be misleading, and lead to false conclusions.

Therefore, such percentages can only be used as a relative index to pollution. However, when a particular sample contained less than 50 percent sensitive organisms, it was considered to indicate some degree of pollution. In certain instances consideration had to be given to the nature of the stream bottom where the sample was collected. As an example, very little of the biological data collected on the Missouri River and its tributaries below Fort Peck Dam can be evaluated by the Percent Sensitive Method. The streams in this area have a shifting sand and mud bottom, water is slow flowing, summer water temperatures are high, and suitable habitat for bottom dwelling organisms virtually lacking. This is well expressed by the small number of organisms taken at most of these stations, and the complete absence of many groups of organisms. In only 3 of the 33 sampling stations below Fort Peck Dam (See Appendix C, Stations 114 to 146) were there sufficient organisms collected to be worthy of consideration as pollution indicators.

Appendix C lists the sample station numbers, the date the samples were taken, the number of square feet of stream substrate sampled, and the number and types of macro-invertebratescollected at each station. The number, but not the type, of fish collected with the sampler are also listed in this Appendix. Fish are taken incidental to macro-invertebrate sampling and are neither considered sensitive or insensitive to pollution in this report.

Appendix C shows the total macro-invertebrates collected at each sampling station, the number of sensitive macro-invertebrates collected, and the percentage of sensitive macro-invertebrates for each station. Also listed are the average number of macro-invertebrates per square foot of stream bottom sampled at each station during this survey.

DISCUSSION

For a discussion of the biological results the Missouri River Drainage in Montana is divided into the following sub-sections: (1) Jefferson River Drainage; (2) Madison River Drainage; (3) Gallatin River Drainage; and (4) Missouri River mainstem and tributaries from its source at Trident, Montana to the Montana-North Dakota Border.

Except for the Madison River Drainage only those stations considered polluted are discussed.

(1) Jefferson River Drainage: Twenty-six stations were sampled in the Jefferson River Drainage. Of these 26 stations, biological samples indicate that seven are to some degree polluted. These polluted stations are numbers 8, 9, 13, 16, 19, 21, and 22.

Stations 8 and 9 are located on the Beaverhead River above and below the City of Dillon, Montana respectively. Biological samples collected at these stations indicate polluted conditions. No explanation can be given for the conditions at Station 8. The City of Dillon has had a sewage lagoon in operation since 1955, indicating that the polluted condition at Station 9 is not directly from this city's main sewage system.

Station 13 is located on Alder Creek (tributary to the Ruby River) below Nevada City. At this station rather severe polluted conditions are

indicated by the biological samples. Many individual septic tanks at Virginia City, discharge into Daylight Creek, a short distance before it joins Alder Creek. The discharge from these septic tanks doubtlessly accounts for the low number of sensitive macro-invertebrates found at this station.

Biological indicators reveal that Station 16, located on the Beaverhead River above the City of Twin Bridges, was severely polluted during the 1958 sampling period, but show greatly improved conditions during the 1959 sampling period. No concrete reason can be given for this change.

Station 19 is located on the Jefferson River approximately one mile below the confluence of the Beaverhead and Big Hole Rivers. Biological indicators reveal a slight degree of pollution at this station. A speculation would be that this is due to organic pollution carried to the Jefferson River by the Beaverhead River.

Stations 21 and 22 are located on Whitetail Creek near Whitehall, a tributary to the Jefferson River. Whitetail Creek receives organic pollution from the City of Whitehall. Biological samples collected during the survey at these two stations indicate gross pollution of Whitetail Creek. This is particularly apparent at Station 22. Sewage treatment facilities are presently under construction at the City of Whitehall.

(2) Madison River Drainage: One station, Number 27, was sampled on the Madison River. The samples collected at this station reveal clean water conditions. It should be mentioned that this station is located only two miles above the mouth of the river.

(3) Gallatin River Drainage: Stations 28 through 40 represent the sampling carried out in the Gallatin River drainage. Three of these, Stations 30, 34, and 36, were sampled during both 1958 and 1959.

Only two stations in the Gallatin River drainage, Numbers 34 (1959) and 36 (1959), appear to be polluted. Station 34 is located on the East Gallatin River below Bozeman Creek but above the City of Bozeman sewage outfall. The 1958 sampling at this station revealed slight polluted conditions, whereas the 1959 sampling revealed gross polluted conditions. Although this station is located above the City of Bozeman sewage outfall, it is located below the effluent of the Vollmer Slaughterhouse.

Samples collected at Station 36, like Station 34, revealed less polluted conditions in 1958 than in 1959. Station 36 is located on the East Gallatin River approximately one mile below the Bozeman sewage outfall.

(4) Missouri River Mainstem and Tributaries from Trident, Montana to the Montana-North Dakota Border: Biological samples collected in the Missouri River and tributaries from Trident, Montana to Helena, Montana reveal clean stream conditions. In this sampling area (Stations 41 through 49) high numbers of sensitive macro-invertebrates were collected.

Evidence of organic pollution is found at Stations 50 and 51, located on Prickly Pear Creek. This is particularly so at Station 51, which is

below the City of Helena. Construction of a sewage treatment plant by the City of Helena is now in progress.

Samples taken at Station 52 on Seven Mile Creek near Fort Harrison (Helena), reveals gross polluted conditions. Seven Mile Creek receives sewage from Fort Harrison below this station. Irrigational practices above this station may account for the polluted conditions indicated.

The samples collected at Station 53 on the Missouri River near Craig, reveal a low number of macro-invertebrates. Holter Reservoir is located immediately above this sampling station, and no doubt fluctuating water levels, because of the reservoir, are responsible for the low number of organisms collected in the samples. So few-macro-invertebrates were taken at this station that percentage determination would be invalid.

Sampling at Stations 56 and 57, located on the Smith River near White Sulphur Springs indicate polluted conditions. However, since these samples were collected sewage treatment facilities have been placed in operation at White Sulphur Springs.

Sensitive and total macro-invertebrate numbers are again low for the samples collected at Station 62, on the Missouri River below Morony Reservoir. This low number is perhaps due to fluctuating water levels in the river brought about by Morony Reservoir.

Samples collected at Stations 77 and 78, located on Willow Creek above and below the City of Browning, respectively reveal polluted conditions. This is particularly so at Station 78. At this station sensitive organisms were virtually lacking.

Big Spring Creek below the City of Lewistown sewage outfall is severely polluted. Samples collected at this station, Number 98, show a high total number of organisms, but an extremely low number of sensitive organisms.

The Musselshell River below the old Harlowton sewage outfall at Stations 108 and 109 was polluted during the time of the survey. Sewage treatment facilities have been placed in operation at Harlowton since the samples were collected.

Biological information collected on the Musselshell River near the City of Roundup, Stations 110 and 111, is difficult to evaluate. The 1958 sampling revealed only 78 organisms, and the 1959 sampling produced only 3 organisms. No attempt is made here to determine, by the samples collected, if the stream is polluted at this station. The same can be said for biological samples collected at Station 112 on the Musselshell River near Mosby. It should be mentioned that the Musselshell River in the area where these samples were taken has a muck-ooze bottom. Such conditions are not favorable habitat for many types of macro-invertebrates.

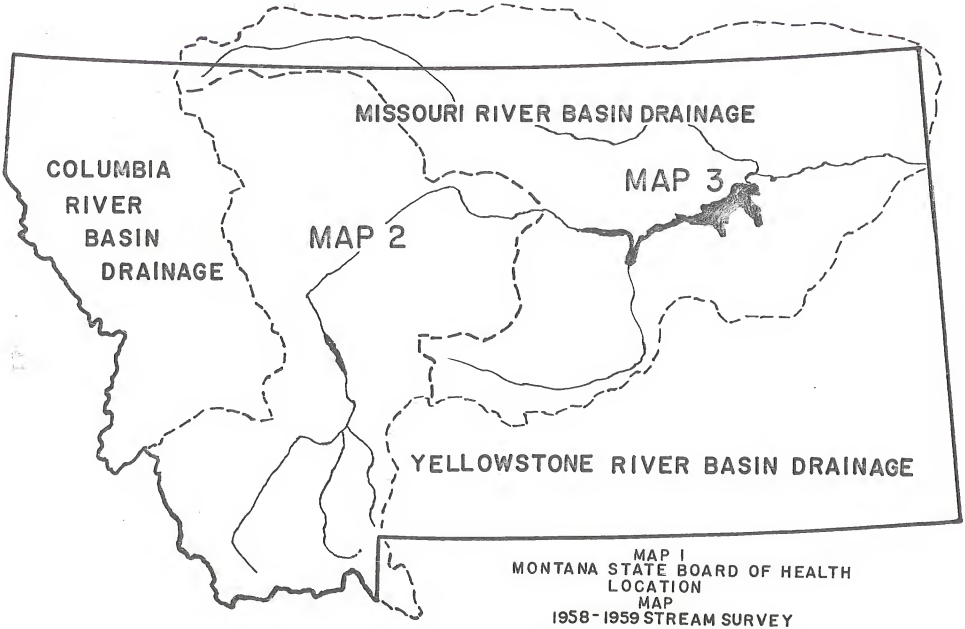
As mentioned earlier in this report it is difficult, if not impossible, by use of macro-invertebrates, to evaluate water quality in the Missouri River and its tributaries below Fort Peck Reservoir. Only at Stations 114, 128, and 129 were there sufficient macro-invertebrates collected in the samples taken to be worthy of consideration in this report.

Station 114, located on the Missouri River immediately below Fort Peck Reservoir contained a total of 627 macro-invertebrates in eight square feet of stream bottom sampled. Only three of these organisms were of the pollution sensitive type. It appears that the bottom type (sand, gravel, muck-ooze and mud) is more of a factor in determining the types of macro-invertebrates found at this station than is the possibility of organic enrichment from pollution. However, Fort Peck Reservoir may contribute some enrichment to the water at this station, and also water leaving the reservoir may be low in dissolved oxygen content.

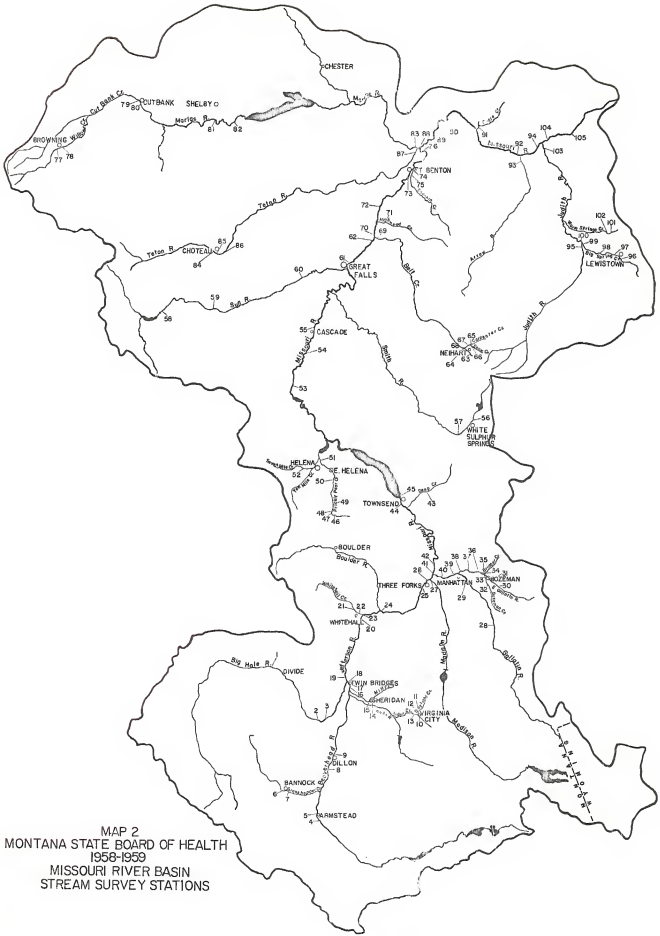
The Milk River near Malta, at Stations 128 and 129, was polluted at the time of the survey. This was particularly so at Station 129 where only four percent of the organisms collected were of the clean water type. The City of Malta has placed into operation sewage treatment facilities since this survey.

SUMMARY

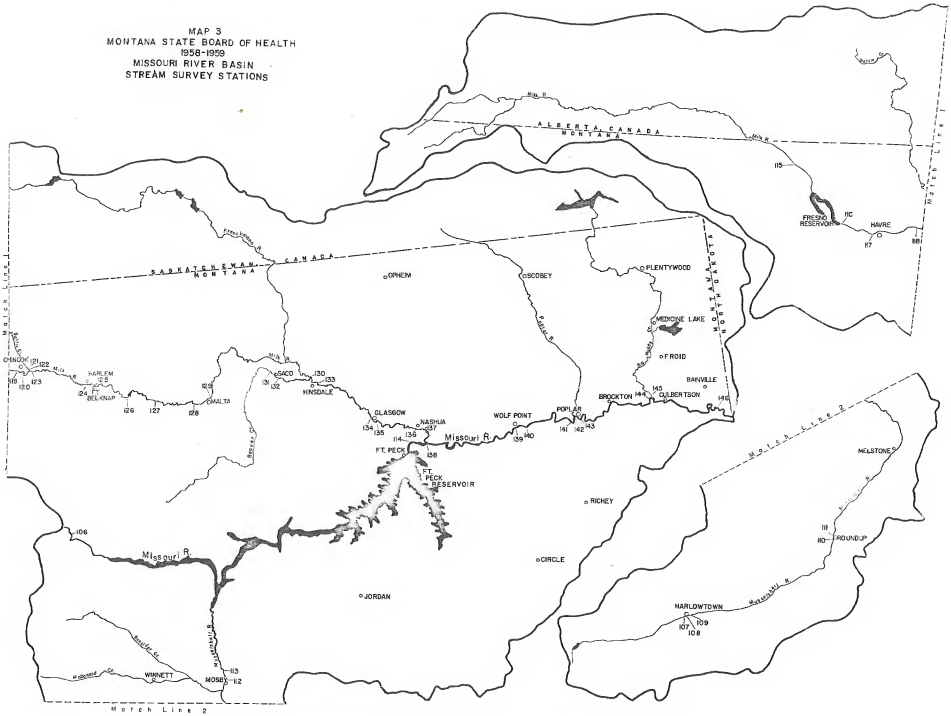
Biological sampling reveals that 21 of the 146 stations sampled in the Missouri River Drainage are polluted. Since this survey was completed the construction of sewage treatment plants has accelerated in many of these areas. Such construction has undoubtedly eliminated much of pollution that existed at the time of this survey. Inorganic pollution appears to be almost non-existent in the drainage except for siltation due to over-grazing and poor farming practices. It is possible in a survey of this size to miss some sources of pollution. However, we are confident that if such areas were missed they were of minor importance. In general, the Missouri River Drainage, biologically, exhibits clean water conditions.



MAP I
MONTANA STATE BOARD OF HEALTH
LOCATION
MAP
1958-1959 STREAM SURVEY


CHESTER
CUTBANK
SHELBY
BROWNING
Marias R.
Cut Bank Cr.
Teton R.
CHOTEAU
Sun R.
GREAT FALLS
Missouri R.
Belt Cr.
Smith R.
Judith R.
Musselshell R.
Yellow Water Cr.
Box Elder Cr.
Big Spring Cr.
Arrow Cr.
Deer Lodge Cr.
Belt Cr.
Dry Cr.
Sheep Cr.
Ft. Benton
Ft. Peck Res.
Ft. Peck Dam
Big Spring Cr.
Big Spring Cr.
Big Spring Cr.

MAP 3
MONTANA STATE BOARD OF HEALTH
1958-1959
MISSOURI RIVER BASIN
STREAM SURVEY STATIONS


ALBERTA, CANADA
MONTANA
SASKATCHEWAN, CANADA
MONTANA
Milk R.
Frenchman R.
Big Muddy Cr.
Poplar R.
Redwater R.
Musselshell R.
Missouri R.
Marias R.
Teton R.
Sun R.
Belt Cr.
Sheep Cr.
Smith R.
Judith R.
Yellowstone R.
Bighorn R.
Bighorn Cr.
Little Bighorn R.
Rosebud Cr.
Tongue R.
Powder R.
Little Powder R.
Little Missouri R.
Little Muddy Cr.
Little Missouri R.
Match Line 2
Match Line 2
FRESNO RESERVOIR
HAVRE
ORMEM
SCOBEY
PLENTYWOOD
MEDICINE LAKE
FROID
BANVILLE
BROCKTON
OLDERTSON
CHINOOK
HARLEM
BELKNAP
MALTA
SACO
HINSDALE
GLASGOW
NASHUA
WOLF POINT
POPLAR
FT. PECK
FT. PECK RESERVOIR
RICHEY
CIRCLE
JORDAN
MELSTONE
ROUNDUP
NARLOWTOWN
WINNETT
MOSBY
Missouri R.
Missouri R.
Missouri R.

Appendix A. Locations and descriptions of sampling stations established during the summer of 1958 and 1959 on the Missouri River Drainage System and their corresponding Missouri River and Tributaries Drainage indices.

MISSOURI RIVER DRAINAGE SYSTEM
(Excluding Yellowstone River Drainage)

STA. NO.	LOCATION	MILEAGE INDEX	DESCRIPTION
	Jefferson River Drainage		
1	Big Hole River above Divide	2464.4-111	Near State Highway 43 bridge four miles west of Divide.
2	Big Hole River above South Dakota Mining and Uranium Company Mill	2464.4-78	Approximately eight miles southeast of Glen and one mile west of mill.
3	Big Hole River below South Dakota Mining and Uranium Company Mill	2464.4-76	Approximately one-fourth mile east of mill.
4	Beaverhead (Red Rock) River above Armstead	2464.4-65-50	Upstream from Armstead approximately one mile near U.S. Highway 91 on Parke Scott Ranch.
5	Beaverhead (Red Rock) River below Armstead	2464.4-65-48	Approximately one mile downstream from Armstead on U.S. Highway 91 just above historical marker.
6	Grasshopper Creek above Bannack	2464.4-65-39-23	Approximately one mile above Bannack near Bannack State Park sign.
7	Grasshopper Creek below Bannack	2464.4-65-37-20	Approximately one-half mile below Security Mines Company dredging operations.
8	Beaverhead River above Dillon	2464.4-65-31	Near U.S. Highway 91 bridge three miles southwest of Dillon.
9	Beaverhead River below Dillon	2464.4-65-26	Near U.S. Highway 91 bridge one mile north of Dillon.
10	Alder Creek above Daylight Creek and Virginia City	2464.4-65-7-20-17	Approximately one-half mile upstream on Alder Creek from Virginia City near historical marker.

Appendix A, Continued

11	Daylight Creek above Virginia City and Alder Creek	2464.4-65-7-20-16-2	Approximately one and one-half miles southeast of Virginia City near State Highway 34.
12	Daylight Creek above Alder Creek and below Virginia City	2464.4-65-7--20-16-0.5	At State Highway 34 crossing in Virginia City.
13	Alder Creek below Virginia City and Daylight Creek	2464.4-65-7-20-13	Approximately two miles northwest of Alder and just below Nevada City.
14	Mill Creek above Sheridan	2464.4-65-5-18	Near road east of Sheridan 3.6 miles.
15	Mill Creek below Sheridan	2464.4-65-5-11	On Hansen farm 2.8 miles southwest of Sheridan.
16	Beaverhead River above Twin Bridges	2464.4-65-4.5	Approximately 300 yards above fairgrounds at Twin Bridges on left bank.
17	Beaverhead River below State Children's Home in Twin Bridges	2464.4-65-3.5	Near State Children's Home barns.
18	Beaverhead River below Twin Bridges	2464.4-65-2	Approximately one mile north of Twin Bridges.
19	Jefferson River below Big Hole, Ruby and Beaverhead Rivers	2464.4-64	Near road along left bank approximately one mile below confluence.
20	Jefferson River above Whitetail Creek	2464.4-44	1.7 miles south of Whitehall below county bridge.
21	Whitetail Creek above Whitehall	2464.4-40-10	Three miles north of Whitehall.
22	Whitetail Creek below Whitehall	2464.4-40-1	Approximately one-half mile below Whitehall sewage outfall.
23	Jefferson River Channel of Jefferson River near Whitehall.	2464.4-39.5	Near Roy Harris Ranch corral about one and one-fourth miles southeast of Whitehall.
24	Jefferson River below Confluence of Boulder River	2464.4-30	Approximately one-half mile below LaHood Park entrance junction with U.S. Highway 10S.
25	Jefferson River above Three Forks	2464.4-7	Near U.S. Highway 10 bridge, approximately two miles west of Three Forks.

Appendix A, Continued

26	Jefferson River below Three Forks	2464.4-3	Near county bridge approximately one and one-half miles east of Three Forks.

Madison River Drainage

27	Madison River near Three Forks	2464.4-2	Near U. S. Highway 10S approximately one mile east of Three Forks.

Gallatin River Drainage

28	West Gallatin River near Gallatin Gateway	2464-42.5	Near east channel bridge at edge of Gallatin Gateway.
29	West Gallatin River near Manhattan	2464-16	Upstream from U.S. Highway 10S bridge approximately three miles southeast of Manhattan.
30	East Gallatin River above Bozeman (locally called Rocky Creek)	2464-10-36	Near Highway 10S near Mount Ellis Road.
31	East Gallatin River above Vollmer Slaughterhouse near Bozeman	2464-10-33	Approximately one-fourth mile south of slaughterhouse by bridge near Bozeman city limits.
32	Bozeman Creek above Bozeman	2464-10-31.7-10	Near bridge approximately five miles south of Bozeman city center.
33	Bozeman Creek below Bozeman	2464-10-31.7-0.1	Approximately 100 feet above confluence with East Gallatin River.
34	East Gallatin River below Bozeman Creek and above Bozeman sewage outfall	2464-10-31.5	Near Bridger Canyon road bridge approximately 300 yards north of sewage treatment plant.
35	Bridger Creek near Bozeman	2464-10-30.5-1	Near bridge on county road approximately one mile above confluence with East Gallatin River.
36	East Gallatin River below Bozeman	2464-10-30	Near county bridge approximately one mile below Bozeman sewage treatment outfall and landfill garbage disposal.

37	East Gallatin River near Belgrade	2464-10-20	Near county bridge approximately one and one-half miles east and one and one-half miles north of Belgrade.
38	East Gallatin River near Manhattan	2464-10-0.2	One-fourth mile above the confluence of the East and West Gallatin Rivers.
39	Gallatin River below confluence of East and West Gallatin Rivers	2464-9	Approximately one mile below confluence and two miles north of Manhattan.
40	Gallatin River near Logan	2464-5	Approximately one-half mile west of Logan near county bridge.

Missouri River and Tributaries after Headwaters

41	Missouri River above Trident	2463.5	Approximately one-half mile downstream of confluence of Madison, Jefferson and Gallatin Rivers.
42	Missouri River below Trident	2462	Approximately one-fourth mile northeast of Trident.
43	Deep Creek near Townsend	2426-8	Approximately five miles east of Townsend near city water intake.
44	Missouri River above Townsend	2425	Approximately two miles south of Townsend on Hahn Ranch.
45	Missouri River below Townsend	2422	Approximately one mile downstream from U.S. Highway 12 bridge on Paul Ragen's Ranch.
46	Prickly Pear Creek above Jefferson City	2372.5-44	Above gold dredge (in operation at time of survey) approximately 0.5 mile south of Jefferson City.
47	Prickly Pear Creek at Jefferson City	2372.5-43	Below bridge east of Ling's Bar in Jefferson City.
48	Prickly Pear Creek below Jefferson City	2372.5-38	At G. Ross Ranch four miles north of Jefferson City near U.S. Highway 91.
49	Prickly Pear Creek near Montana City	2372.5-25	Approximately one-half mile south of U.S. Highway 91 railroad overpass approximately six miles southeast of Helena.

Appendix A, Continued

50	Prickly Pear Creek above East Helena	2372.5-23	At county road bridge near Montana City.
51	Prickly Pear Creek below Helena	2372.5-11	Near bridge on county road south of State Girls' Vocational School.
52	Seven Mile Creek near Fort Harrison	2372.5-9.4-5.5	Near railroad crossing approximately two miles northwest of Fort Harrison entrance on county road.
53	Missouri River near Craig	2333	Near county bridge at Craig.
54	Missouri River above Cascade	2319	Near U.S. Highway 91 bridge approximately ten miles southwest of Cascade.
55	Missouri River below Cascade	2305	Approximately one mile downstream from Cascade near county road water pump.
56	North Fork Smith River above White Sulphur Springs	2280-115-10	Near U.S. Highway 89 bridge approximately three miles northeast of White Sulphur Springs
57	Smith River near White Sulphur Springs	2280-112	Near county bridge four miles west of White Sulphur Springs
58	Sun River below Gibson Dam and Sun River Diversion Dam	2252.2-85	Approximately one mile below Sun River Diversion Dam.
59	Sun River near Augusta	2252.2-63	Near State Highway 287 bridge approximately four miles northeast of Augusta.
60	Sun River near community of Sun River	2252.2-29	Near State Highway 20 bridge at Sun River.
61	Missouri River at Rainbow Dam Forebay	2244	Forebay of Montana Power Company's Rainbow Dam near Great Falls.
62	Missouri River below Morony Dam	2236	Below Montana Power Company's Morony Dam.
63	Belt Creek above Neihart	2234.2-74	Near U.S. Highway 89 approximately one mile southeast of Neihart.

Appendix A, Continued

64	Belt Creek above Carpenter Creek	2234.2-67.2	Near U.S. Highway 89, 1.2 miles northwest of center of Neihart.
65	Carpenter Creek above Snow Creek	2234.2-67-2.2	Approximately one mile north of Neihart and 2.2 road miles from U.S. Highway 89.
66	Snow Creek above Carpenter Creek	2234.2-67-2-0.2	Approximately one mile north of Neihart and approximately one-fourth mile above Carpenter Creek.
67	Carpenter Creek below Snow Creek	2234.2-67-1.8	Approximately one mile north of Neihart and approximately one-fourth mile below confluence of Snow Creek.
68	Belt Creek below Carpenter Creek	2234.2-66	Near U.S. Highway 89 approximately one-fourth mile north of Carpenter Creek road junction and near side-road bridge across Belt Creek.
69	Belt Creek above Missouri River	2235-2	Approximately 3.5 miles north of Salem near county road bridge.
70	Missouri River below Belt Creek	2234	On left bank of Missouri approximately 1.5 miles below Morony Dam.
71	Highwood Creek above Missouri River	2228.1-4	Near bridge approximately four miles above confluence with Missouri River.
72	Missouri River at Carter Ferry	2220	At ferry east of Carter.
73	Missouri River above Fort Benton	2203	Near Fort Benton water treatment plant intake.
74	Missouri River below Fort Benton	2201	Approximately one mile below Fort Benton park near city center.
75	Shonkin Creek above Missouri River	2200-3	Near bridge on FAS 230 one mile east of Fort Benton.
76	Missouri River above Marias River (Innominate River)	2183	At Loma ferry one mile southeast of Loma.
77	Willow Creek above Browning	2181-223-18	Near bridge on U.S. Highway 89 three miles west of Browning

Appendix A, Continued

78	Willow Creek below Browning	2181-223-13	One and one-half miles east of Browning.
79	Cut Bank Creek above Cut Bank	2181-201	Near bridge on U.S. Highway 2 west of Cut Bank.
80	Cut Bank Creek below Cut Bank	2181-199	Southwest of Cut Bank on extension of Ninth Avenue.
81	Marias River south of Shelby	2181-168	Near U.S. Highway 91 bridge six miles south of Shelby.
82	Marias River southeast of Shelby	2181-156	Near FAS 417 road bridge approximately ten miles southeast of Shelby.
83	Marias River above Teton River	2181-3	Approximately one-half mile above confluence with Teton River.
84	Teton River near Choteau	2181-1.5-129	Near State Highway 287 bridge one mile south of Choteau.
85	Teton River below Choteau	2181-1.5-127	Near bridge on U.S. Highway 89 one mile southeast of Choteau.
86	Teton River east of Choteau	2181-1.5-117	Near bridge on FAS 221 road four miles east of Choteau. Greenfield Lake drainage enters above this station.
87	Teton River above Marias River	2181-1.5-0.5	Near county road bridge approximately one-half mile west of Loma.
88	Marias River (Innominate River) below Teton River	2181-1	Approximately one-half mile below confluence Teton River and east of U.S. Highway 87 bridge at Loma.
89	Missouri River below Marias River (Innominate River)	2180	Approximately one-half mile below confluence.
90	Missouri River at Virgelle Ferry	2162.2	Approximately 100 feet upstream of USGS gagehouse at Virgelle Ferry.
91	Eagle Creek above Missouri River	2145-1	Above confluence with Missouri River (dry at time of survey).

Appendix A, Continued

92	Missouri River above Arrow Creek	2124	Above confluence with Arrow Creek.
93	Arrow Creek above Missouri River	2123-1	Above confluence with Missouri River (dry at time of survey).
94	Missouri River above Judith River	2117	Approximately two miles above confluence with Judith River.
95	Judith River above Big Spring Creek	2114.7-56	Approximately 300 yards above confluence with Big Spring Creek.
96	Big Spring Creek above Lewistown	2114.7-55-18	Near FAS 238 bridge 2.6 miles southeast of Lewistown.
97	Big Spring Creek below Lewistown	2114.7-55-13	Near FAS 237 bridge approximately two miles northwest of Lewistown.
98	Big Spring Creek at Hanover	2114.7-55-7	Near railroad trestle at Hanover approximately seven miles northwest of Lewistown.
99	Big Spring Creek above Judith River	2114.7-55-0.1	Approximately 150 yards above confluence with Judith River.
100	Judith River below Big Spring Creek	2114.7-53	Approximately two miles below confluence.
101	Warm Springs Creek above USAF Radar Base	2114.7-44-27	Approximately one-half mile above radar base and approximately eleven miles northeast of Lewistown.
102	Warm Springs Creek below USAF Radar Base	2114.7-44-25	Approximately one mile below radar base and approximately eleven miles northeast of Lewistown.
103	Judith River above Missouri River	2114.7-4	Approximately four miles above confluence with Missouri River at Charles Wilson Ranch.
104	Missouri River below Judith River	2113	At State Highway 236 Missouri River ferry crossing.
105	Missouri River at No Crossing	2100	Approximately twelve miles north of Winifred.
106	Missouri River at State Highway 19 Crossing	2056	At State Highway 19 crossing approximately 65 miles northeast of Lewistown.

Appendix A, Continued

107	Musselshell River above Harlowton	1994.7-281	Near State Highway 19 bridge one mile southwest of Harlowton.
108	Musselshell River below Harlowton-1	1994.7-278.2	Near county bridge approximately two miles southeast of Harlowton.
109	Musselshell River below Harlowton-2	1994.7-272	Near county bridge approximately four miles southeast of Harlowton.
110	Musselshell River above Roundup	1994.7-173	Near U.S. Highway 87 bridge approximately two miles southwest of Roundup.
111	Musselshell River below Roundup	1994.7-169	Near county bridge one mile east of Roundup.
112	Musselshell River near Mosby	1994.7-60	Near State Highway 20 bridge near Mosby.
113	Musselshell River below Mosby	1994.7-50	Approximately eight miles north of Mosby and below Cat Creek oilfield.
114	Missouri River below Fort Peck	1864	Approximately five road miles downstream from Ft. Peck near power line overpass.
115	Milk River above Fresno Reservoir	1857.4-460	Approximately twenty-three miles north of Gilford on Vande Sandt Ranch.
116	Milk River below Fresno Reservoir	1857.4-417	Approximately one mile below Fresno spillway along left bank.
117	Milk River above Havre	1857.4-402	Approximately 100 feet upstream from City of Havre new water intake.
118	Milk River near Lohman	1857.4-376	Near U.S. Highway 2 bridge two miles east of Lohman.
119	Milk River above Chinook	1857.4-364	Downstream 50 feet from City of Chinook water intake.
120	Milk River below Chinook	1857.4-359	At Mitchel farm two miles southeast of Chinook.
121	Battle Creek (West Fork Milk River) above Diamond Asphalt Company	1857.4-357-4	Near U.S. Highway 2 bridge in Chinook.

122	Battle Creek (West Fork Milk River) below Diamond Asphalt Company	1857.4-357-2	Near county bridge approximately one mile southeast of Diamond Asphalt Company.
123	Milk River below Battle Creek	1857.4-353	At county road bridge approximately five miles east of Chinook.
124	Milk River above Harlem	1857.4-329	Upstream ten feet from Town of Harlem water intake.
125	Milk River above Fort Belknap	1857.4-325	Above Fort Belknap water intake 300 feet.
126	Milk River above Dodson Dam	1857.4-277	Near Blaine-Phillips County line approximately eight miles northwest of Dodson on north-south gravel road.
127	Milk River near Dodson	1857.4-259	Near bridge on FAS 204 one mile south of Dodson
128	Milk River above Malta	1857.4-226	Near GN tracks five miles west of Malta.
129	Milk River below Malta	1857.4-214	Approximately one mile northeast of Malta on Hans Kualle Farm.
130	Milk River above Hinsdale and Beaver Creek	1857.4-126	West of bridge on gravel road two miles north of Hinsdale.
131	Beaver Creek above Saco	1857.4-125-31	East of bridge on gravel road three miles northwest of Saco.
132	Beaver Creek below Saco	1857.4-125-20	Southeast of Saco three miles on Buttington's Farm.
133	Milk River below Hinsdale and Beaver Creek	1857.4-118	Near U.S. Highway 2 bridge two miles east of Hinsdale.
134	Milk River above Glasgow	1857.4-61	Behind Glasgow hospital and Civic Center and above sewage outfall.
135	Milk River below Glasgow	1857.4-57	Near State Highway 24 bridge three miles southeast of Glasgow.

136	Milk River above Nashua	1857.4-26	Near bridge on Nashua-Fort Peck highway (FAS 249) one mile southwest of Nashua.
137	Milk River below Nashua	1857.4-17	Approximately one-half mile south of U.S. Highway 2, two miles southeast of Nashua.
138	Missouri River below Milk River	1857	Approximately one-half mile below confluence of Missouri and Milk Rivers.
139	Missouri River above Wolf Point	1801	Approximately one mile upstream from Wolf Point.
140	Missouri River below Wolf Point	1794	Approximately eight miles downstream from Wolf Point.
141	Missouri River above Poplar and Poplar River	1776	Directly across west channel of Missouri River from mouth of Poplar River.
142	Poplar River above Missouri River	1775.8-0.5	Approximately one-half mile above confluence Poplar and Missouri Rivers.
143	Missouri River below Poplar and Poplar River	1774	Approximately one and one-half miles below confluence Poplar and Missouri Rivers.
144	Missouri River above Big Muddy Creek	1726	Along north bank 300 yards upstream from confluence of Missouri River and Big Muddy Creek.
145	Big Muddy Creek above Missouri	1725.7-0.1	Approximately 250 yards upstream from confluence of Missouri River and Big Muddy Creek.
146	Missouri River at Snowden	1686	Under bridge at Snowden.

Appendix B.

CHEMICAL, PHYSICAL, AND BACTERIOLOGICAL DATA
OBTAINED DURING 1958 AND 1959 STREAM SURVEY ON THE
MISSOURI RIVER DRAINAGE SYSTEM

Sta. No.	Date	Time	Stream Flow Cfs	Water Temp. °F	Dissolved Oxygen ppm	Dissolved Oxygen % Sat.	pH	Total Alkalinity as ppm CaCO3	Hardness ppm	Chlorides ppm Cl-	Sulfates ppm SO_4	Turbidity ppm	MPN Coli. Bact. per 100 ml.	Date Taken	Time Taken	Sta. No.
1	7-28-58	6 PM	750	66	7.4	99	8.7	75	58	3	7	< 7	23	8-11-58	6 PM	1
2	7-8-59	6 PM	1,840[1]	60	8.6	102	8.6	92	75	3	19	< 7				2
3	7-8-59	4 PM.	1,840	60	8.6	102	8.6	92	75	3	19	< 7				3
4	7-9-59	9 AM	258[1]	54	9.6	104	8.3	260	314	17	35	15				4
5	7-9-59	11 AM	258[1]	54	10.8	122	8.7	256	321	21	19	16				5
6	7-9-59	3 PM	67	68	8.0	107	8.2	100	101	8	24	< 7				6
7	7-9-59	5 PM	67	66	7.4	97	8.2	104	106	8	24	30				7
8	7-28-58	10 AM	344[1]	61	9.2	114	8.5	272	289	17	70	< 7	93	8-11-58	12 N	8
9	7-28-58	2 PM	344	66	12.6	164	8.5	262	289	17	70	< 7	2300	8-11-58	1 PM	9
10	7-10-59	2 PM	8,41	60	8.0	100	8.4	116	163	4	5	9				10
11	7-10-59	5 PM	0.51													11
12	7-10-59	4 PM	0.51	68			7.9	252	246							12
13	7-10-59	3 PM	101	67	8.8	121	9.0	170	422	7	10	9				13
14	7-10-59	11 AM	47[1]	48	9.4	99	7.5	46	48	1	5	< 7				14
15	7-10-59	10 AM	47	54	9.2	104	8.6	186	222	10	24	9				15
16	7-29-58	10 AM	68[1]	63	7.6	95	7.7	259	309	19	117	<10	430	8-11-58	4 PM	16
17	8-18-59	1 PM	274	60	9.0	106	8.5	238	357	18	187	15	93	8-17-59	5 PM	16
18	8-18-59	10 AM	274	--	5.2	---	8.5	242	357	21	226	25	2300	8-17-59	5 PM	17
19	7-29-58	2 PM	880	67	9.1	119	8.0	146	151	8	25	< 7	23	8-11-58	3 PM	19
20	7-30-58	8 AM	770[1]	64	7.4	92	7.9	178	186	10	33	15	230	8-11-58	5 PM	20
21	7-29-58	6 PM	1	63	7.4	91	7.9	103	70	9	15	20	230	8-11-58	5 PM	21
22	7-30-58	12 N		55	3.6	40	7.7	293	381	72	117	25	2300	8-11-58	6 PM	22
23	7-30-58	11 AM		62	6.8	82	7.8	257	276	51	157	20				23
24	7-30-58	3 PM	770	68	8.7	113	8.2	190	189	10	34	11	93	8-11-58	6 PM	24
25	8-11-58	10 AM	770[1]	73	9.0	121	8.0	179	209	11	63	< 7	210	8-12-58	2 PM	25
26	8-17-59	4 PM	344[1]	68	9.4	119	8.4	204	483	18	110	10	430	8-17-58	4 PM	26
26	8-11-58	12 N	770	73	8.3	111	7.9	190	206	13		< 7	43000	8-12-58	12 N	26
27	8-12-58	3 PM		66	8.6	106	8.4	204	485	22	110	9	7500	8-17-59	2 PM	26
28	6-29-59	3 PM	2,480	77	9.0	125	8.7	115	78	17		<10	23	8-11-58	4 PM	27
29	8-11-58	10 AM		56	9.6	97	7.5	86	77	3	12	45	150	7-8-59	8 AM	28
30	7-31-58	1 PM		67	8.8	97	7.6	145	157	3		< 7	230	8-12-58	5 PM	29
30	6-30-59	3 PM	33	60	7.8	100	7.8	221	210	2	30	13	4300	8-11-58	9 PM	30
31	7-8-59	8 AM	53	48	8.4	99	8.9	180	213	1	12	14	7500	7-8-59	7 AM	30
32	7-6-59	4 PM	16[1]	59	9.6	98	8.2	174	193	3	5	120				31
33*	7-8-59	11 AM	40		8.0	94	7.9	122	140	3	5	14	1200	7-8-59	7 AM	32
34	7-31-58	4 PM	54[1]	70									2,500,000	8-19-59	7 AM	33
34	7-6-59	10 AM	93	59	8.1	108	8.5	198	187	2		24	43,000	8-11-58	8 PM	34
35	6-30-59	11 AM	56	51	8.4	104	8.4	179	191	3	10	47	43,000	7-8-59	7 AM	34
36*	7-31-58	9 AM	54	58	9.8	114	8.4	174	191	3	10	40	9,300	7-8-59	7 AM	35
36	6-30-59	8 AM	180[1]	48	7.6	88	7.8	226	187	4	17	40	110,000	8-11-58	9 AM	36
37	8-1-58	10 AM		63	9.8	100	8.2	179	198	7	12	43	23,000	7-8-59	7 AM	36
38	8-1-58	2 PM		72	10.0	165	8.4	232	202	6	17	24	2,300	8-11-58	7 PM	37
39	8-12-58	10 AM	515	66	9.0	105	8.4	208	190	8	27	17	430	8-11-58	7 PM	38
40	8-11-58	7 AM	515	63	8.0	98	8.2	206	206	8		19	230	8-12-58	11 AM	39
41	8-11-58	3 PM		76	11.4	153	8.8	178	165	12	31	13	430	8-12-58	5 PM	40
41	6-29-59	12 N	11,400	51	9.0	93	7.7	108	127	5	10	52	430	8-12-58	5 PM	41
42	6-29-59	10 AM	11,400	65	9.2	94	7.7	108	127	7	10.	60	4,300	7-8-59	9 AM	41
43	8-18-58	2 PM		66	8.3	105	8.3	228	226	6	35	<13	3,900	7-8-59	9 AM	42
44	8-18-58	1 PM	12,000	72	9.2	121	8.8	162	148	15	55	11				43
45	8-19-58	8 AM		65	7.0	86	7.9	179	173	15		11				44
46	6-18-59	2 PM	59	52	8.4	86	7.3	15	25	4	10	6				45
47	6-18-59	4 PM	35	51	8.6	87	7.1	14	32	6	10	2952				46
48	6-19-59	10 AM	76	51	6.8	88	7.3	21	60	8	24	832				47
49	6-19-59	1 PM	116	60	8.2	92	7.3	25	65	6	19	562				48
50	8-19-58	11 AM	20	64	8.2	101	7.8	79	111	4	63	262				49
51	8-19-58	2 PM	5	70	7.4	96	7.6	184	210	12		16				50
52	8-20-58	9 AM	1	57	8.6	97	8.2	235	246	6		14				51
53	8-20-58	1 PM	6,470	66	9.3	116	8.8	156	173	13		<10				52
54	8-20-58	3 PM		66	10.0	121	8.8	154	165	11		<10				53
55	8-20-58	5 PM		68	9.8	121	8.8	156	161	13		< 8				54
56	8-22-58	3 PM		64	10.8	131	8.7	222	190	3	9	12				55
57	8-22-58	5 PM		70	11.6	153	8.6	226	190	10	31	< 7				56
58	8-27-58	2 PM		63	9.0	104	8.4	134	161	0	17	< 7				57
59	8-27-58	12 N		65	8.6	104	8.4	158	190	6	61	< 7				58
60	8-27-58	9 PM		64	8.2	97	8.4	250	301	4	164	17				59
61*	8-11-59	8 AM	4,320				8.4	172	202	15	87	24	9,300	8-4-59	7 AM	60
61	8-5-59	6 AM	4,780		7.6	90	8.7	180	205	14	120	40				61
62	8-6-59	10 AM	20[1]	48	8.4	90	7.7	102	92	5	5	2				62
63	8-6-59	12 N	34	56	8.4	99	7.7	96	92	5	10	2				63
63*	8-6-59	1 PM	2.2	66	7.0	94	7.1	50	103	3	76	12				64
64	8-6-59	3 PM	1.4									2				65
67	8-6-59	5 PM	3.5	60	7.6	94	7.1	52	99	3	76	1				66
68*	8-6-59	4 PM	35	60	8.0	100	7.6	86	101	3	24	2				67
69	8-7-59	11 AM	43	70	7.6	95	8.6	138	194	2	87	8				68
70	8-11-59	6 AM	4,110	65	7.8	91	8.5	178	233	18	168	20				69
71	8-7-59	1 PM	9.7	72	8.6	109	8.9	182	552	11	245	6				70
72	8-4-59	12 N	4,750				8.7	180	194	14	110	40				71
73*	7-29-59	7 AM	2,640				8.7	186	206	19	115	30	2,300	7-28-59	9 AM	72
74	8-5-59	11 AM	2,640	64	8.8	101	8.7	172	203	16	115	26				73
75		Dry except for intermittent puddles														74
76	8-5-59	1 PM	4,450	68	8.8	105	8.7	192	206	14	115	26				75
																76

*See more detailed survey results in Tables 5, 6, 7, 8, 9, 10, 11, and 12

[1]estimated flow

[2]Turbidity by Seckman spectrophotometer

[3]Fe=1.0 ppm, As=.000, Zn= 0.8, Pb= 0.00, Cu= 0.0

[4]Fe=0.6 ppm, As=.003, Zn= 0.4, Pb= 0.00, Cu= 0.0

[5]Fe=2.5 ppm, As=.004, Zn= 0.8, Pb= 0.03, Cu= 0.0

Appendix B, Continued

Sta. No.	Date	Time	Stream Flow Cfs	Water Temp. °F	Dissolved Oxygen ppm	% Sat.	pH	Total Alkalinity as ppm CaCO3	Hardness ppm	Chlorides ppm Cl-	Sulfates ppm SO4	Turbidity ppm	Coli. Bact. per 100 ml.	MPN Date Taken	Time Taken	Sta. No.
77	8-26-58	12 N		64	9.4	116	8.8	164	161	2	9	<7				77
78	8-26-58	10 AM		63	6.7	81	7.7	149	165	4	25	<7				78
79	8-25-58	6 PM	80	73	7.8	103	9.0	135	140	4	46	<7				79
80	8-26-58	7 AM	80	64	6.5	78	7.8	145	155	8	54	<7				80
81	8-25-58	5 PM	238	75	7.8	104	8.4	170	214	6	122	30				81
82	8-25-58	3 PM	238	75	8.3	114	8.5	178	227	6	168	35				82
83	8-10-59	3 PM	1,400	64	8.4	96	8.4	168	277	5	220	25				83
84	8-10-59	2 PM	1201	70	8.2	105	8.2	226	272	4	44	<7				84
85	8-26-58	5 PM	1201	70	8.5	109	8.4	198	239	4	46	10				85
86	8-26-58	4 PM	1201	72	8.1	105	8.6	247	408	23	425	20				86
87	8-10-59	2 PM	231	72	7.6	95	8.5	248	374	14	348	14				87
88	8-5-59	4 PM	1,420	70	8.0	98	8.9	194	306	10	260	50				88
89	8-5-59	3 PM	1	66	7.8	91	8.9	162	273	8	216	18				89
90*	8-11-59	6 PM	5,240	66			8.5	172	233	12	139	14				90
91	8-14-59	Dry at time of survey														91
92	8-14-59	10 AM	6,140	62	8.8	99	8.5	182	238	12	120	13				92
93	8-14-59	Dry at time of survey														93
94	8-13-59	9 AM	5,950	60	8.6	93	8.6	178	242	18	178	15				94
95	6-25-59	5 PM	413	67			8.4	192	250	8	8		930	6-24-59	8 AM	95
96	6-25-59	9 AM	115	54	8.1	86	8.1	182	346	7	24	9	75	6-24-59	8 AM	96
97	6-25-59	10 AM	118	55	10.9	115	8.2	202	380	10	29	10	9,300	6-24-59	7 AM	97
98	6-25-59	2 PM	118	65	9.0	110	8.9	206	371	4	6	12	9,300	6-24-59	7 AM	98
99*	6-25-59	5 PM	254	67	7.1	85	8.7	202	320	10	8	150	4,300	6-24-59	8 AM	99
100*	6-25-59	12 N	667	66			8.7	200	272	8	8	160	750	6-24-59	8 AM	100
101	6-24-59	10 AM	2	56	8.7	95	8.2	154	206	12	7	<7	93	6-24-59	7 AM	101
102	6-24-59	12 N	4	60	7.9	90	7.7	122	130	10	5	<7	230	6-24-59	7 AM	102
103	8-13-59	1 PM	132	63	8.8	100	8.3	166	489	6	380	12				103
104	8-13-59	11 AM	5950	61	8.6	94	8.5	174	322	10	226	17				104
105	8-13-59	3 PM	6580	63	9.2	103	8.4	170	230	10	154	30				105
106	8-12-59	2 PM	6160	68	8.4	100	8.4	172	224	11	159	30				106
107	8-22-58	11 AM	53	64	9.2	112	8.6	277	556	14	443	<7				107
108	8-22-58	7 AM	53	63	5.9	70	7.9	271	555	19	574	<7				108
109	8-22-58	9 AM	53	64	8.7	106	8.2	265	556	19	554	<7				109
110	8-26-58	10 AM	460	65	7.3	86	8.4	222	452	11	216	200				110
111	8-21-58	4 PM	236	72	8.2	104	8.4	214	443	17	566	60				111
112	8-21-58	1 PM	30	77	8.4	110	8.4	214	640	33	1311	35				112
113	6-25-59	4 PM	620	64	7.6	87	8.9	216	398	15	58	200				113
114	6-18-58	7 AM		51	8.8	85	8.2	175	200	9	140	16	43	6-23-58	2 PM	114
115	6-29-58	11 AM		61	8.9	101	8.2	172	136	3	50	175	230			115
116	6-29-58	8 AM		62	8.6	99	8.2	168	118	5	65	<22	230	6-29-58	9 AM	116
117	6-28-58	3 PM		68	7.8	94	8.2	172	129	6	60	65	43	6-26-58	4 PM	117
118	6-26-58	1 PM		68	7.5	91	8.3	178	132	7	65	65	2,100,000	6-26-58	3 PM	118
119	6-28-58	11 AM		68	7.2	87	8.2	172	129	8	65	85	23,000	6-26-58	2 PM	119
119	8-11-59	2 PM		66	8.0	95	8.4	164	145	5	62	85				119
120	6-26-58	9 AM		68	7.3	89	8.3	176	129	8	65	>60				120
121	8-11-59	1 PM	10	66	7.2	84	7.5	310	348	10	266	80				121
122	8-11-59	10 AM	10	62	9.0	100	8.4	192	189	7	168	75				122
123	8-11-59	11 AM	1	63	7.8	88	8.4	168	132	9	87	75	9,300	6-26-58	2 PM	123
124	6-27-58	5 PM		73	8.4	107	8.2	184	140	7	80	>45	2,300	6-26-58	12 N	124
125	6-27-58	4 PM		75	8.2	106	8.3	188	144	8	80	>45	9,300	6-26-58	11 AM	125
126	7-27-58	12 N		73	8.1	101	8.2	218	158	7	95	50	4,300	6-26-58	11 AM	126
127	6-27-58	11 AM		74	8.0	101	8.2	224	169	9	115	>60				127
128	6-25-58	5 PM		69	7.8	93	8.3	250	191	10	175	75	390	6-25-58	5 PM	128
129	6-25-58	1 PM		68	8.2	97	8.2	254	195	10	165	115	7,500	6-25-58	1 PM	129
130	6-24-58	5 PM		67	7.8	92	8.3	254	210	10	205	90	15	6-25-58	10 AM	130
131	6-25-58	11 AM	3	64	11.0	124	8.7	254	272	15	350	<7	43	6-25-58	11 AM	131
132	6-25-58	1 PM		67	10.9	128	9.0	258	301	34	445	7	93	6-25-58	1 PM	132
133	6-24-58	4 PM		65	7.9	90	8.3	256	202	10	200	60	430	6-25-58	9 AM	133
134	6-24-58	2 PM		65	7.8	89	8.4	260	206	9	210	110	930	6-25-58	9 AM	134
135	6-24-58	1 PM		65	7.2	82	8.2	244	208	14	185	130	93,000	6-25-58	8 AM	135
136	6-24-58	9 AM		65	7.6	84	8.3	248	213	15	240	250	1,500	6-24-58	3 PM	136
137	6-24-58	10 AM	400	65	7.6	84	8.2	248	212	17	240	250	4,300	6-23-58	5 PM	137
138	6-18-58	11 AM	1	54	8.6	86	8.3	171	213	12	160	45				138
139	6-19-58	3 PM	5800	59	8.2	87	8.3	180	210	10	150	75	210	6-23-58	4 PM	139
140	6-20-58	7 AM	5800	59	8.2	89	8.2	192	212	12	150	90	1,500	6-23-58	3 PM	140
141	6-20-58	4 PM	5800	61	8.4	91	8.3	194	213	11	140	75	430	6-24-58	5 PM	141
142	6-20-58	2 PM	1	69	7.2	85	8.8	456	202	87	210	65	430	6-24-58	5 PM	142
143	6-20-58	5 PM	5800	61	8.4	91	8.4	206	215	14	150	100	93	6-24-58	5 PM	143
144	6-22-58	8 AM	5240	59	8.2	90	8.3	212	217	11		85	93	6-24-58	7 PM	144
145	6-22-58	8 AM	2	63	6.8	76	7.0	790	424	15	460	130				145
146	6-22-58	4 PM	5240	63	8.0	90	8.3	214	217	13	150	145				146

*See more detailed survey results in Tables 5, 6, 7, 8, 9, 10, 11, and 12
estimated flow

Appendix C

Date of Collection, Number of Square Feet Stream Substrate Sampled, Number of Fish Collected, Number and Types of Invertebrates Collected, Total Invertebrates, Total Sensitive Invertebrates, Percent Sensitive Invertebrates, and Average Number of Invertebrates per Square Foot Collected from Stations Sampled in the Missouri River Drainage, Montana.

Sta. No.	Date	Square Feet Sampled	Types and Numbers of Organisms Collected: Eph.	Ple.	Tri.	Odn.	Colso.	Dipt.	Olig.	Hiru.	Gast.	Fish	Others	Invertebrates Total	Total Sensitive	Percent Sensitive	Ave. No. per Sq. Ft.	Sta. No.
1	7-28-58	8	142	43	55	0	9	144	0	0	23	0	2	427	240	56	53	1
2	7-8-59	8	243	16	16	0	3	122	2	0	0	5	5	407	275	68	51	2
3	7-8-59	8	194	66	5	0	5	88	0	0	0	0	0	358	265	74	45	3
4	7-9-59	8	750	11	1500	0	0	182	300	0	8	0	0	2751	2261	82	688	4
5	7-9-59	8	1274	59	501	0	0	165	210	0	16	0	0	2225	1834	82	278	5
6	7-9-59	8	91	18	71	0	7	31	35	0	2	0	0	255	180	71	32	6
7	7-9-59	8	50	4	7	0	5	4	0	0	0	0	0	70	61	87	9	7
8	7-28-58	8	297	20	436	0	0	1297*	96	0	9	0	0	2155+	753	36-	269+	8
9	7-26-58	8	274	8	152	0	7	1380*	74	0	3	0	0	1898+	434	23-	273+	9
10	7-10-59	8	47	4	79	66	40	0	0	0	0	0	0	236	190	55	61	10
11	7-10-59	N/A	Reconnaissance Sample											Reconnaissance Sample				11
12	7-10-59	N/A	Reconnaissance Sample											Reconnaissance Sample				12
13	7-10-59	4	22	4	8	0	21	400	4	0	0	0	0	459	44	7	115	13
14	7-10-59	8	103	15	65	0	4	48	4	0	2	0	0	241	183	76	30	14
15	7-10-59	8	281	4	164	0	11	125	47	0	7	0	0	639	449	70	80	15
16	7-29-58	8	178	0	28	0	4	1312*	0	62	3	1	0	1587	206	13	198	16
	8-16-59	4	888	32	121	0	45	217	49	0	10	0	2	1364	1041	76	341	
17	8-16-59	4	978	6	16	0	29	80	165	0	0	0	14	1288	1000	78	322	17
18	8-16-59	8	400	29	34	1	15	200	6	0	0	0	0	685	464	68	86	18
19	7-29-58	8	113	16	25	1	5	116*	141*	0	0	0	0	417+	154	37-	52+	19
20	7-30-58	8	181	98	891	1	25	84	264*	0	2	1	0	1544+	1170	76-	193+	20
21	7-29-58	8	98	19	305*	11	168	45	60	0	1200*	0	0	1906	433	23	238+	21
22	7-30-58	4	2	0	12	0	0	1200*	1200*	1200*	1200*	0	0	4814+	34	1-	1205+	22
23	7-30-58	4	267	22	155	0	4	181	35	0	4	0	3	671	444	66	17	23
24	7-30-58	8	164	10	456	5	3	51	35	16	100	0	3	843	635	75	105	24
25	8-1-58	8	371	101	220	13	12	43	34	0	1	0	0	795	705	89	99	25
	8-17-59	4	345	56	126	0	8	92	0	0	0	0	0	625	525	84	78	
26	8-1-58	8	721	142	314	0	17	161	41	0	2	0	2	1400	1177	84	175	26
	8-17-59	8	145	0	5	0	0	78	13	0	4	0	0	245	148	61	30	
27	8-12-58	8	90	7	1553*	0	69	20	2	0	2	0	32	1775+	1650+	93+	222+	27
28	6-29-59	8	79	3	24	0	0	12	0	0	0	0	0	118	106	90	15	28
29	8-1-58	8	137	117	650	0	17	377	0	0	3	1	0	1301	904	69	163	29
30	7-31-58	8	60	6	549*	0	54	43	0	0	9	0	2	723	615	85	90	30
	6-30-59	4	278	18	358	0	31	6	2	0	6	0	0	701	654	93	175	
31	7-8-59	4	85	3	141	0	4	86	0	0	0	0	0	322	232	72	80	31
32	6-7-59	8	51	4	495	0	38	126	0	0	2	0	1	717	550	77	90	32
33	7-8-59	N/A	Reconnaissance Sample											Reconnaissance Sample				33
34	7-31-58	4	110	12	239	0	9	182	238	0	8	0	0	798	561	45	200	34
	7-6-59	8	237	9	111	0	1	137	5254	0	6	0	0	5755	357	6	719	
35	6-30-59	8	134	10	938	0	3	15	0	0	5	183	6	1131	1102	97	141	35
36	7-31-58	4	1200*	18	0	1	1	91	1200*	0	12	0	0	2522+	1228+	48	315+	36
	6-30-59	8	351	2	95	0	2	500	2002	0	4	0	0	2956	448	15	370	
37	8-1-58	8	487	15	824	0	7	128	42	0	12	0	5	1520	1326	87	190	37
38	8-1-58	8	93	18	1105	0	2	50	2	0	5	0	1	1276	1216	95	160	38
39	8-12-58	8	126	48	653	1	17	144	11	0	5	0	6	1009	826	82	126	39
40	8-1-58	8	387	49	1268*	0	26	252	137	0	11	0	1	2131+	1704+	80+	266+	40
41	8-11-58	8	559	98	1446*	3	50	143	5	0	2	0	1	2307+	2106+	91+	288+	41
	6-29-59	8	303	52	176	0	4	43	0	0	6	0	0	584	531	91	73	
42	6-29-59	8	110	10	81	0	19	40	0	0	0	0	1	261	201	76	33	42
43	8-18-58	8	47	73	388	0	46	201*	0	0	0	1	0	755	508	67	94	43
44	8-18-58	8	130	25	254	0	17	94	11	0	6	0	0	537	409	76	67	44
45	8-19-58	8	172	46	441	0	96	184	108	0	1	1	0	1048	659	63	131	45
46	6-18-59	8	21	5	7	0	0	0	2	0	0	0	0	35	33	94	3	46
47	6-18-59	8	271	29	1	0	0	42	4	0	0	0	0	347	301	87	43	47
48	6-19-59	8	30	17	107	0	0	50	0	0	0	0	0	204	154	75	43	48
49	6-19-59	8	9	45	47	54	1	28	3	0	2	1	0	189	155	82	16	49
50	8-19-58	8	8	5	19	2	2	73	1	0	1	0	0	111	34	31	14	50
51	8-19-58	8	3	0	2	0	2400*	2400*	0	0	0	11	16	4816+	5	1-	602+	51
52	8-20-58	8	55	31	126	0	152	2400*	2	0	3	0	16	2785+	212	8-	348+	52
53	8-20-58	8	0	0	2	0	0	30	26	0	0	0	0	58	2	3	7	53
54	8-20-58	8	69	0	19	0	5	31	7	0	36	0	7	174	88	51	22	54
55	8-20-58	8	1790*	13	248	0	26	89	10	0	10	0	0	2186+	2051+	94+	273+	55
56	8-22-58	8	307	7	29	4	41	309	19	0	55	0	3	774	547	45	97	56
57	8-22-58	4	144	3	37	5	375	16	18	19	24	0	23	664	189	28	167	57
58	8-27-58	8	217	119	15	0	2	152	0	0	1	0	38	544	351	65	68	58
59	8-27-58	8	49	16	63	0	1	12	0	0	0	0	0	142	128	90	18	59
60	8-27-58	8	97	17	0	0	1	98	11	0	1	0	0	225	114	51	56	60
61	8-12-59	N/A	Chemical Samples Only											Chemical Samples Only				61
62	8-5-59	8	2	0	62	0	0	68	17	0	5	0	2	156	64	41	20	62
63	8-6-59	8	117	28	21	0	30	30	4	0	0	0	0	230	166	72	29	63
64	8-6-59	8	117	32	173	0	45	25	0	0	0	0	0	392	322	82	49	64
65	8-6-59	8	0	2	26	0	0	4	0	0	0	0	0	32	28	88	4	65
66	8-6-59	4	55	22	12	0	0	0	0	0	0	0	2	91	89	98	23	66
67	8-6-59	8	11	4	23	0	0	2	0	0	0	0	0	40	36	95	5	67
68	8-6-59	8	82	14	22	0	14	12	2	0	0	0	0	146	118	81	18	68
69	8-7-59	8	5	24	223	0	1	9	0	0	0	0	0	262	252	96	87	69
70	8-11-59	N/A	Reconnaissance Sample											Reconnaissance Sample				70
71	8-7-59	8	128	49	262	0	22	176	1	0	1	0	55	694	439	63	87	71

Eph.=Ephemeroptera; Ple.=Plecoptera; Tri.=Trichoptera; Odn.=Odonata; Colso.=Coleoptera; Dipt.=Diptera; Olig.=Oligochaeta; Hiru.=Hirudinea; Gast.=Gastropoda.

Includes Amphipoda, Arachnida, Decapoda, Hemiptera, Isopoda, Nematoda, and Turbellaria

* Estimated Number - too numerous to count, or small forms escaped in debris

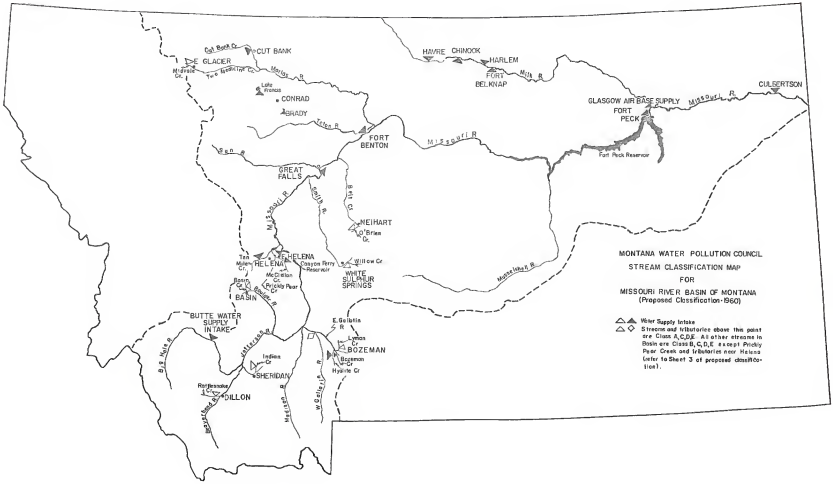
\+ = less than figure given

\- = more than figure given

N/A = Not Applicable

Appendix C, Continued

Sta. No.	Date	Square Feet Sampled	Types and Numbers of Organisms Collected: Enh.	Pleo.	Tric.	Odon.	Coleo.	Dist.	Olig.	Hiru.	Gast.	Fish	Other.	Invertebrates Total	Total Sensitive	Percent Sensitive	Ave. No. per Sq. Ft.	Sta. No.
72	8-4-59	4	0	0	275	0	0	0	0	0	1	0	0	276	275	100	69	72
73	6-29-59	8	0	0	83	0	1	3	1	6	0	2	2	96	85	86	12	73
74	8-5-59	6	16	1	601	0	4	10	1	0	0	0	0	633	618	98	79	74
75	8-5-59	N/A			Stream Bed Dry										Stream Bed Dry			75
76	8-5-59	8	1	0	17	2	0	6	4	0	0	0	1	31	20	65	4	76
77	8-26-58	4	12	14	70	0	77	40	1	0	305	0	8	527	96	18	132	77
78	8-26-58	8	24	3	17	3	2	177*	253	26	118	0	583	1206	47	4	151	78
79	8-25-58	8	23	131	65	22	93	27	0	0	10	0	8	379	241	64	47	79
80	8-26-58	8	28	363	81	8	17	301	8	34	2	0	3	845	480	57	106	80
81	8-25-58	8	36	25	130	20	6	4	0	0	0	0	0	219	209	95	27	81
82	8-25-58	8	69	98	200	10	2	11	2	0	0	0	1	393	377	96	49	82
83	8-10-59	8	66	7	65	0	0	3	0	0	0	1	0	141	138	96	18	83
84	8-26-58	8	1	99	43	3	1	47	0	0	9	0	2	209	148	71	26	84
85	8-26-58	8	12	6	196	1	3	95	1	0	5	1	0	321	215	67	40	85
86	8-26-58	8	6	21	311	7	19	85	3	0	2	0	2	456	345	76	57	86
87	8-10-59	8	19	0	43	1	0	5	0	0	0	0	0	66	63	94	8	87
88	8-5-59	8	85	0	200	4	6	7	0	0	0	0	0	302	289	96	38	88
89	8-5-59	8	48	0	4	0	0	5	0	0	0	0	0	57	52	91	7	89
90	8-11-59	8	23	1	132	0	2	19	0	0	1	0	1	179	156	87	22	90
91	8-14-59	N/A			Stream Bed Dry										Stream Bed Dry			91
92	8-14-59	8	23	1	155	0	0	6	0	0	0	2	0	185	179	97	23	92
93	8-14-59	N/A			Stream Bed Dry										Stream Bed Dry			93
94	8-13-59	8	50	3	120	1	4	38	4	0	0	0	0	222	176	79	28	94
95	6-23-59	8	57	0	46	0	20	37	0	0	0	1	0	160	103	64	20	95
96	6-25-59	8	202	230	3000	0	14	46	42	0	15	1	1	3550	3432	97	459	96
97	6-25-59	8	1500	62	32	0	4	332	1002	0	5	0	106	3063	1614	53	382	97
98	6-24-59	8	230	36	17	0	18	1625	3003	0	19	7	0	4948	285	6	550	98
99	6-23-59	8	304	155	415	0	8	17	0	13	2	0	0	914	874	96	114	99
100	6-25-59	12	286	77	64	2	6	15	11	0	4	2	40	505	429	85	42	100
101	6-24-59	8	471	88	8	0	4	109	6	0	1	0	0	687	567	83	87	101
102	6-24-59	8	153	53	0	0	3	45	6	0	0	0	0	260	206	79	33	102
103	8-13-59	8	30	15	502	12	0	10	0	0	0	0	0	569	559	98	71	103
104	8-13-59	8	13	0	10	0	0	6	4	0	0	0	0	33	23	70	4	104
105	8-13-59	8	92	6	482	1	1	23	3	0	0	2	0	608	581	96	76	105
106	8-12-59	8	17	0	48	0	0	23	0	0	0	4	0	92	65	71	12	106
107	8-22-58	8	115	3	771	36	107	33	1	7	75	0	116	1264	925	73	16	107
108	8-22-58	8	125	1	135	38	239*	1250*	102	18	186	0	14	2086+	297	14-	261+	108
109	8-22-58	4	40	1	1200*	9	152*	1200*	2	13	279	0	26	2922+	1250	43-	730+	109
110	6-26-59	8	1	0	10	1	0	1	1	0	7	0	0	21	12	57	3	110
111	8-21-58	8	51	0	6	0	0	10	4	0	0	0	0	71	57	80	9	111
	6-26-59	8	0	0	0	0	0	0	3	0	0	0	0	3	0	0	1-	
112	8-21-58	8	54	5	0	1	0	2	0	0	0	0	0	62	60	95	8	112
	6-25-59	12	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
113	6-25-59	N/A			Reconnaissance Sample										Reconnaissance Sample			113
114	6-16-58	8	0	0	3	0	3	509	74	0	0	0	38	627	3	1-	7	114
115	6-29-58	8	33	0	1	0	0	3	0	0	0	0	0	37	34	92	5	115
116	6-29-58	8	7	0	0	0	0	270	0	0	0	0	3	273	7	3	34	116
117	6-28-58	8	61	0	0	2	0	7	0	0	0	0	0	70	63	90	9	117
118	6-28-58	8	0	0	0	0	0	9	2	0	0	0	0	11	0	0	1	118
119	6-28-58	8	0	0	0	2	0	4	4	0	0	0	0	10	2	20	1	119
	8-11-59	8	0	0	0	4	0	4	0	0	0	8	4	20	4	20	3	
120	6-28-58	8	0	0	0	3	0	10	6	0	0	3	2	22	3	14	3	120
121	8-11-59	8	0	0	0	8	1	30	0	0	7	61	75	182	8	4	23	121
122	8-11-59	8	0	0	0	0	0	0	0	0	3	2	0	5	0	0	1-	122
123	8-11-59	8	7	0	0	3	0	0	0	0	1	0	0	11	10	91	1	123
124	6-27-58	8	1	0	0	0	1	8	2	0	0	0	3	15	1	7	2	124
125	6-27-58	8	10	0	0	0	0	2	0	0	0	0	8	20	10	50	3	125
126	6-27-58	8	4	0	0	0	0	3	5	0	0	0	0	11	4	36	2	126
127	6-27-58	8	18	0	0	0	0	3	2	0	0	0	0	28	18	64	4	127
128	6-25-58	4	220	0	121	1	24	1200*	64	0	0	0	0	1630+	342	21-	408+	128
129	6-25-58	8	56	0	1	0	0	28	7	0	1200*	0	1	1293+	57	4-	162+	129
130	6-25-58	8	0	0	0	0	0	23	0	0	2	0	14	39	0	0	5	130
131	6-25-58	8	32	0	15	1	2	11	0	6	90	0	29	186	48	26	23	131
132	6-25-58	8	16	0	0	0	0	34	0	0	6	0	3	59	16	27	7	132
133	6-24-58	8	7	0	0	0	0	65	0	0	0	0	23	115	7	62	14	133
134	6-24-58	8	10	0	0	0	0	6	0	0	0	0	25	41	10	24	5	134
135	6-24-58	8	0	0	0	0	1	6	2	0	0	0	19	28	0	0	4	135
136	6-24-58	8	0	0	0	0	0	29	0	0	0	0	71	100	0	0	13	136
137	6-24-58	8	0	0	0	0	0	18	0	0	0	0	11	29	0	0	4	137
138	6-18-58	8	0	0	0	0	0	59	18	0	0	0	0	77	0	0	10	138
139	6-19-58	4	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1-	139
140	6-20-58	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	140
141	6-20-58	4	0	0	0	0	0	3	0	0	0	0	0	3	0	0	1	141
142	6-[illegible]-58	8	1	0	1	0	1	17	0	0	0	0	2	22	3	14	3	142
143	[illegible]-58	12	2	0	0	0	0	3	0	0	0	0	0	5	2	40	1-	143
144	6-22-58	8	0	0	2	0	0	6	3	0	0	0	0	11	2	18	1	144
145	6-22-58	8	1-	0	0	0	0	0	0	0	0	0	500	501	1	0	63	145
146	6-22-58	8	7	0	0	3	0	1	0	0	0	0	0	11	10	91	1	146


MONTANA WATER POLLUTION COUNCIL
STREAM CLASSIFICATION MAP
FOR
MISSOURI RIVER BASIN OF MONTANA
(Proposed Classification-1960)
Water Supply Intake
Streams and tributaries above this point are Class A,C,D,E. All other streams in Basin are Class B, C, D, E except Prickly Pear Creek and tributaries near Helena (refer to Sheet 3 of proposed classification).
Cut Bank Cr
CUT BANK
E GLACIER
Midvale Cr
Two Medicine Cr
Marias R
Lake Frances
CONRAD
BRADY
Teton R
Sun R
FORT BENTON
Missouri R
GREAT FALLS
MISSOURI R
Smith R
Belt Cr
MEIHART
O'Brien Cr
Tenmile Cr
HELENA
HELENA
Hauser Reservoir
Willow Cr
WHITE SULPHUR SPRINGS
McClellan
Prickly Pear
Ranch
BASIN
Beaverhead R
BUTTE WATER SUPPLY INTAKE
Jefferson R
E Gallatin R
Gallatin
Cr
BOZEMAN
Bozeman Cr
Hyalite Cr
Indian Cr
SHERIDAN
B R Mus R
Red Rock R
DILLON
Beaverhead R
Madison R
W Gallatin R
Big Hole R
HAVRE
CHINOOK
HARLEM
FORT BELKNAP
Milk R
GLASGOW AIR BASE SUPPLY
FORT PECK
Missouri R
CULBERTSON
Fort Peck Reservoir

PROPOSED
MONTANA STATE WATER POLLUTION COUNCIL
STREAM CLASSIFICATION
FOR
MISSOURI RIVER AND TRIBUTARIES

Appendix D

(Excluding Yellowstone and Little Missouri Rivers & Tributaries)

BODY OF WATER[1] Order[2] Second	Third	Fourth	Fifth	Sixth	LOCATION	PRESENT USE	REMARKS	CLASSIFICATION Present	Proposed
				(MISSOURI RIVER	DRAINAGE AREA IN MONTANA)				
		Beaverhead River and tributaries except Rattlesnake Creek and Ruby River			From source to Jefferson River	Ag, F&R, PS		B,C,D,E	B,C,D,E
			Rattlesnake Creek and tributaries		From source to City of Dillon water supply intake	WSp, Ag, F&R	City of Dillon water supply	A,C,D,E	A,C,D,E
					From City of Dillon water supply intake to Beaverhead River	Ag, F&R		B,C,D,E	B,C,D,E
			Ruby River and tributaries except Indian Creek		From source to Beaverhead River	Ag, F&R, PS		B,C,D,E	B,C,D,E
				Indian Creek and tributaries	From source to City of Sheridan water supply intake	WSp, Ag, F&R	City of Sheridan water supply	A,C,D,E	A,C,D,E
					From City of Sheridan water supply intake to Ruby River	Ag, F&R		B,C,D,E	B,C,D,E
		Big Hole River and tributaries			From source to confluence with Jefferson River	WSp, Ag, F&R	City of Butte Water Supply	A,C,D,E	B,C,D,E
	Jefferson River and tributaries except Whitetail Creek and Boulder River				From confluence of Big Hole and Beaverhead Rivers to Missouri River.	Ag, F&R, PS		B,C,D,E	B,C,D,E

[1] Names of streams, lakes and reservoirs taken from USPS map
[2] A first-order stream is one which terminates at the ocean (consequently, we have no 1st-order streams in Mont.) 2nd-order are tributary to 1st, etc.
[3] at confluence with stream of next largest order listed above
WS Water supply, (p) public, (i) Industrial, (o) private or resort, WP Water Power, PS Public Sewage, IW Industrial Waste, Ag Agriculture, F&R Fishing and Recreation

October 20, 1960

BODY OF WATER[1] Order[2] Second	Third	Fourth	Fifth	Sixth	LOCATION	PRESENT USE	REMARKS	CLASSIFICATION Present	CLASSIFICATION Proposed
		Whitetail Creek and tributaries			From source to City of Whitehall sewage effluent	Ag, F&R		B,C,D,E	B,C,D, E
					From City of Whitehall sewage effluent to Jefferson River	Ag, F&R, PS		B,C,D,E	B,C,D,E
		Boulder River and tributaries except Basin Creek			From source to Jefferson River	Ag, F&R, PS		B,C,D,E	B,C,D,E
			Basin Creek and tributaries		From source to City of Basin water supply intake	WSp, Ag, F&R	City of Basin water supply	A,C,D,E	A,C,D,E
					From City of Basin water supply intake to Boulder River	Ag, F&R		B,C,D,E	B,C,D,E
	Madison River and tributaries				From source to Missouri River	Ag, F&R, PS	Treatment of City of Three Forks sewage planned	B,C,D,E	B,C,D,E
		West Gallatin River and Tributaries			Source to East Gallatin River	WSo, Ag,	Resort and private water supplies - Private sewers	A,C,D,E	A,C,D,E
		East Gallatin River and Tributaries except Bozeman, Bridger and Hyalite Creeks			From source to West Gallatin River	Ag, F&R, PS, IW	City of Bozeman sewage needs chlorinating. Slaughter house waste needs treatment. Several private sewers enter stream.	B,C,D,E	B,C,D,E
			Bozeman Creek and tributaries		From source to East Gallatin River	WSp	City of Bozeman water supply	A,C,D,E	B,C,D,E

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[3] at confluence with stream of next largest order listed above

WS Water supply, (p) public, (i) Industrial, (o) private or resort, WP Water Power, PS Public Sewage, IW Industrial Waste, Ag Agriculture, F&R Fishing and Recreation

Appendix_____

BODY OF WATER[1] Order[2] Second	Third	Fourth	Fifth	Sixth	LOCATION	PRESENT USE	REMARKS	CLASSIFICATION Present	Proposed
			Bridger Creek and tributaries except Lyman Creek		From source to East Gallatin River	Ag, F&R		B,C,D,E	B,C,D,E
				Lyman Creek and tributaries	From source to Bridger Creek	WSp	City of Bozeman water supply	A,C,D,E	A,C,D,E
			Hyalite Creek and tributaries		From source to East Gallatin River	F&R, Ag, WSp	City of Bozeman water supply	A,C,D,E	B,C,D,E
	Gallatin River and tributaries				From confluence of East and West Gallatin Rivers to Missouri River	Ag, F&R	Need further treatment of City of Manhattan sewage	B,C,D,E	B,C,D,E
Missouri River mainstem and tributaries					From confluence of Madison, Jefferson and Gallatin Rivers to Canyon Ferry Dam	WSp, Ag, F&R, IW, PS	Need further treatment of City of Trident sewage. City of Helena water supply taken from Canyon Ferry reservoir in part.	B,C,D,E	B,C,D,E
Missouri River mainstem and tributaries except Prickly Pear Creek, Smith River and Sun River					From Canyon Ferry Dam to Black Eagle Dam	WSp, Ag, F&R, WP, PS	Need treatment of sewage at City of Cascade. Industrial waste at Great Falls. City of Great Falls water supply.	B,C,D,E	B,C,D,E
	Prickly Pear Creek and tributaries except McClellan, Ten Mile and Seven Mile Creeks				From source to Missouri River	Ag, F&R, IW, PS	City of Helena sewage treatment under construction. Effluent from City of East Helena sewage lagoon. Wastes from mining operations.	C,D,E	C,D,E

[1] names of streams, lakes and reservoirs taken from USFS map

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[3] at confluence with stream of next largest order listed above

WS Water supply, (p) public, (i) Industrial, (c) private or resort, WP Water Power, PS Public Sewage, IW Industrial Waste, Ag Agriculture, F&R Fishing and Recreation

Appendix_____

BODY OF WATER[1] Order[2] Second	Third	Fourth	Fifth	Sixth	LOCATION	PRESENT USE	REMARKS	CLASSIFICATION Present	CLASSIFICATION Proposed
		McClellan Creek and tributaries			From source to confluence with Prickly Pear Creek	WSp, Ag, P&R	City of East Helena water supply	A,C,D,E	B,C,D,E
		Ten Mile Creek and tributaries except Seven Mile Creek			From source to City of Helena water supply intake above Rimini	WSp, Ag, P&R	City of Helena water supply	A,C,D,E	B,C,D,E
					From City of Helena water supply intake above Rimini to Prickly Pear Creek	Ag, P&R	Treatment of City of Helena sewage will remove wastes from this stream section	B,C,D,E	B,C,D,E
			Seven Mile Creek and tributaries		From source to Ten Mile Creek	Ag, P&R, PS	Receives Fort Harrison sewage	B,C,D,E	B,C,D,E
	Smith River and tributaries except Willow Creek				From source to Missouri River	Ag, P&R	Receives waste from sewage lagoon at City of White Sulphur Springs	B,C,D,E	B,C,D,E
		Willow Creek and tributaries			From source to Smith River	WSp, Ag, P&R	Water supply for City of White Sulphur Springs	A,C,D,E	A,C,D,E
	Sun River and tributaries				From source to Missouri River	Ag, P&R		B,C,D,E	B,C,D,E
Missouri River mainstem and tributaries except Belt Creek, Marias River, Judith River, Musselshell River and Milk River					From Black Eagle Dam to confluence with Milk River	WSp, Ag, P&R, WSI, IW, PS WP	Needed treatment of City of Fort Peck sewage. Need ~~further~~ treatment of City of Great Falls sewage and meat packing company wastes. City of Fort Benton water supply.	B,C,D,E	B,C,D,E

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[3] At confluence with stream of next largest order listed above
WS Water supply, (p) public, (i) Industrial, (o) private or resort, WP Water Power, PS Public Sewage, IW Industrial Waste, Ag Agriculture, P&R Fishing and Recreation

Appendix____

BODY OF WATER[1] Order[2] Second	Third	Fourth	Fifth	Sixth	LOCATION	PRESENT USE	REMARKS	WATER QUALITY Present	WATER QUALITY Proposed
	Belt Creek and tributaries except O'Brien Creek				From source to Missouri River	WSp, Ag, P&R IW	Industrial wastes from mines near the cities of Neihart, Highsville and Monarch	B,D,D,E	B,D,D,E
		O'Brien Creek and tributaries			From source to Belt Creek	WSp, Ag, P&R	Water supply for City of Neihart	A,D,D,E	A,D,D,E
	Marias River and tributaries except Cut Bank Creek, Two Medicine Creek and Teton River				From source to Missouri River	Ag, P&R		B,D,D,E	B,D,D,E
		Cut Bank Creek and tributaries except Flat Iron Creek			From source to Marias River	WSp, Ag, P&R PS	City of Cut Bank water supply	B,D,D,E	B,D,D,E
			Flat Iron Creek and tributaries		From source to Cut Bank Creek	PS	Receives City of Browning partially treated sewage	B,D,D,E	B,D,D,E
		Two Medicine Creek and tributaries			From source to Cut Bank Creek	Ag, P&R, PS	Receives sewage from East Glacier	B,D,D,E	B,D,D,E
			Midvale Creek and tributaries		From source to Two Medicine Creek	WSp, Ag, P&R PS	East Glacier water supply	A,D,D,E	A,D,D,E
		Teton River and tributaries			From source to Marias River	WSc, Ag, P&R PS	Receives effluent from City of Choteau sewage lagoon	B,D,D,E	B,D,D,E
	Judith River and tributaries except Spring Creek and [illegible]				From source to Missouri River	Ag, P&R		B,D,D,E	B,D,D,E

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[3] At confluence with stream of next largest order listed above
WS Water supply, (p) public, (i) Industrial, (o) private or resort, WP Water Power, PS Public Sewage, IW Industrial Waste, Ag Agriculture, P&R Fishing and Recreation

Appendix_____

BODY OF WATER[1] Order[2] Second	Third	Fourth	Fifth	Sixth	LOCATION	PRESENT USE	REMARKS	CLASSIFICATION Present	CLASSIFICATION Proposed
		Spring Creek and tributaries			From source to Judith River	Ag, F&R, PS	City of Lewistown sewage requires additional treatment	B,C,D,E	B,C,D,E
		Wolf Creek and tributaries			From source to Judith River	Ag, F&R		B,C,D,E	B,C,D,E
	Musselshell River and tributaries except McDonald Creek				From source to Missouri River	Ag, F&R, PS	Water supply for cities of Melstone and Roundup. Receives sewage lagoon effluent from cities of Harlowton, Roundup and Melstone	B,C,D,E	B,C,D,E,
		McDonald Creek and tributaries			From source to Musselshell River	Ag, F&R, PS	Need further treatment of City of Winnett sewage	B,C,D,E	B,C,D,E
	Milk River and tributaries except Beaver Creek				From source to Missouri River	WSp, Ag, F&R, WSI, WSo, IW, PS	Water supply for cities of Havre, Chinook, Harlem, and Fort Belknap. Need further treatment of sewage at towns of Fort Belknap, Hinsdale and Nashua	B,C,D,E	B,C,D,E
		Beaver Creek and tributaries			From source to Milk River	Ag, F&R, PS	Town of Saco sewage requires additional treatment	B,C,D,E	B,C,D,E
Missouri River mainstem and tributaries except Redwater River, Poplar River and Big Muddy Creek					From confluence with Milk River to state line	WSp, Ag, F&R PS	Need further treatment of city of Culbertson water supply. Need further treatment of sewage at cities of Fort Peck, Medicine Lake and Bainville.	A,C,D,E	B,C,D,E

[1] names of streams, lakes and reservoirs taken from USFS map

[2] a first-order stream is one which terminates at the ocean (consequently, we have no 1st-order streams in Mont.) 2nd-order are tributary to 1st, etc. at confluence with stream of next largest order listed above

WS Water supply, (p) public, (i) Industrial, (o) private or resort, WP Water Power, PS Public Sewage, IW Industrial Waste, Ag Agriculture, F&R Fishing and Recreation

Appendix_____

BODY OF WATER[1]								CLASSIFICATION	
Order[2]					LOCATION	PRESENT USE	REMARKS	Present	Proposed
Second	Third	Fourth	Fifth	Sixth					
	Redwater River and tributaries				From source to Missouri River	Ag, F&R, PS		B,C,D,E	B,C,D,E
	Poplar River and tributaries				From source to Missouri River	Ag, F&R, PS	City of Scobey sewage requires additional treatment	B,C,D,E	B,C,D,E
	Big Muddy Creek and tributaries				From source to Missouri River	Ag, F&R, Ps	Sewage from City of Medicine lake requires additional treatment	B,C,D,E	B,C,D,E

[1] names of streams, lakes and reservoirs taken from USFS map

[2] a first-order stream is one which terminates at the ocean (consequently, we have no 1st-order streams in Mont.) 2nd-order are tributary to 1st, etc.

[3] at confluence with stream of next largest order listed above

WS Water supply, (p) public, (i) Industrial, (o) private or resort, WP Water Power, PS Public Sewage, IW Industrial Waste, Ag Agriculture, F&R Fishing and Recreation

STATE OF MONTANA WATER POLLUTION COUNCIL

STREAM CRITERIA FOR WASTE DISCHARGES

WATER QUALITY OBJECTIVES AND MINIMUM TREATMENT REQUIREMENTS FOR MONTANA SURFACE AND UNDERGROUND WATERS

WATER QUALITY WATER USES	ORGANISMS OF THE COLIFORM GROUP	FLOATING, SUSPENDED SETTLEABLE SOLIDS AND SLUDGE DEPOSITS	TASTE OR ODOR PRODUCING SUBSTANCES	DISSOLVED OXYGEN	pH	TOXIC, COLORED, OR OTHER DELETERIOUS SUBSTANCES	PHENOLIC COMPOUNDS	OIL	HIGH TEMPERATURE WASTES	MINIMUM TREATMENT REQUIREMENTS FOR DOMESTIC SEWAGE
(A) WATER SUPPLY, DRINKING, CULINARY, AND FOOD PROCESSING. Without treatment other than simple disinfection and removal of naturally present impurities.	Most probable number (MPN) coliform bacterial content of a representative number of samples should average less than 50 per 100 ml. in any month.	None attributable to sewage, industrial wastes, or other wastes which, after reasonable dilution and mixture with receiving waters, interfere with the best use of these waters for the purpose indicated.	None attributable to sewage, industrial wastes or other wastes.	Greater than five (5) parts per million, except for underground waters.	Hydrogen ion concentration expressed as pH should be maintained between 6.5 and 8.5	None alone or in combination with other substances or wastes in sufficient amounts or of such nature as to make receiving water unsafe or unsuitable for use indicated (U. S. P. H. S. Std.)	Less than five (5) parts per billion	None	Not in sufficient quantities alone or in combination with other wastes to interfere with the use indicated.	Primary treatment and effective disinfection except in special cases as determined by the State Board of Health. Sewage lagoon treatment will meet this requirement.
(B) WATER SUPPLY, DRINKING, CULINARY, AND FOOD PROCESSING. With treatment equal to coagulation, sedimentation, filtration, disinfection, and any additional treatment necessary for removing naturally present impurities	MPN coliform bacterial content of a representative number of samples should average less than 2000 per 100 ml. and should not exceed this number in more than 20 percent of samples examined in any month where associated with domestic sewage.	(Same as for use "A" above).	None attributable to sewage, industrial wastes or other wastes which, after reasonable dilution and mixture, will increase the threshold odor number above eight (8).	Same as for use "A" above.	Same as for use "A" above.	Same as for use "A" above.	Same as for use "A" above.	None detectable	Same as for use "A" above.	Same as for use "A" above.
(C) BATHING, SWIMMING, AND RECREATION. Note: When waters are used for recreational purposes such as fishing and boating, exclusive of bathing and swimming, the number "1000" may be substituted for "2400" in statement of coliform objectives.	MPN coliform bacterial content of a representative number of samples should average less than 240 per 100 ml. and should not exceed this number in more than 20 percent of samples examined in any month where associated with domestic sewage.	Same as for use "A" above.	None attributable to sewage, industrial wastes or other wastes which, after reasonable dilution and mixture, will interfere with the best use of these waters for the purpose indicated.	Greater than five (5) parts per million.	Same as for use "A" above.	Same as for use "A" above.	Less than twenty five (25) parts per billion or none in sufficient amounts so as to impart a residual taste to recreational or commercial fish or other aquatic forms	Same as for use "B" above.	Same as for use "A" above.	Same as for use "A" above.
(D) GROWTH AND PROPAGATION OF FISH AND OTHER AQUATIC LIFE. Including waterfowl, furbearers, and other aquatic and semi-aquatic life.	See note under "C" above.	Same as for use "A" above.	None attributable to sewage, industrial wastes or other wastes which will interfere with the palatability or propagation of recreational or commercial fish or other edible aquatic forms.	Same as for use "C" above.	Same as for use "A" above.	None alone or in combination with other substances or wastes in sufficient amount or of such character as to make receiving waters unsafe or unsuitable for use indicated.	Same as for use "C" above.	Same as for use "B" above	Not in sufficient quantity as to increase the temperature of the receiving water beyond that optimum for the normal aquatic life of the specific water.	Primary treatment and effective disinfection. Sewage lagoon treatment will meet this requirement.
(E) AGRICULTURAL AND INDUSTRIAL WATER SUPPLY Without treatment except for the removal of natural impurities to meet special quality requirements other than those classified under "A" above. Note: Permissible limits for total concentration percent sodium, boron, chlorides, and sulphates to receive further study, suggested value for percent sodium in less than 60. Percent sodium computed as the ratio of sodium to total cations expressed in equivalent weights. Calculated from the formula: Na X 100 ÷ Na + K + Ca + Mg when Na, Ca, K, and Mg are expressed in equivalents.		Same as for use "A" above	None attributable to sewage, industrial wastes or other wastes which will adversely affect the marketability of agricultural or industrial produce.	Greater than three (3) parts per million.	Hydrogen ion concentration expressed as pH should be maintained between 6.0 and 9.5	Same as for use "A" above.	None in sufficient quantity as to make receiving water unsuitable for use indicated.	Same as for use "B" above	Same as for use "A" above.	Same as for use "D" above.

Water Quality Objectives of a watercourse will apply at the point of discharge of a waste except in special cases where the sampling points will be determined by the Montana Water Pollution Council.

Determinations in the above table will be in accordance with "Standard Methods for the Examination of Water, Sewage and Industrial Wastes".

Adopted tentatively Feb. 28, 1956
Revised April, 1958
Reviewed Sept. 2, 1958